

Mapping the real world

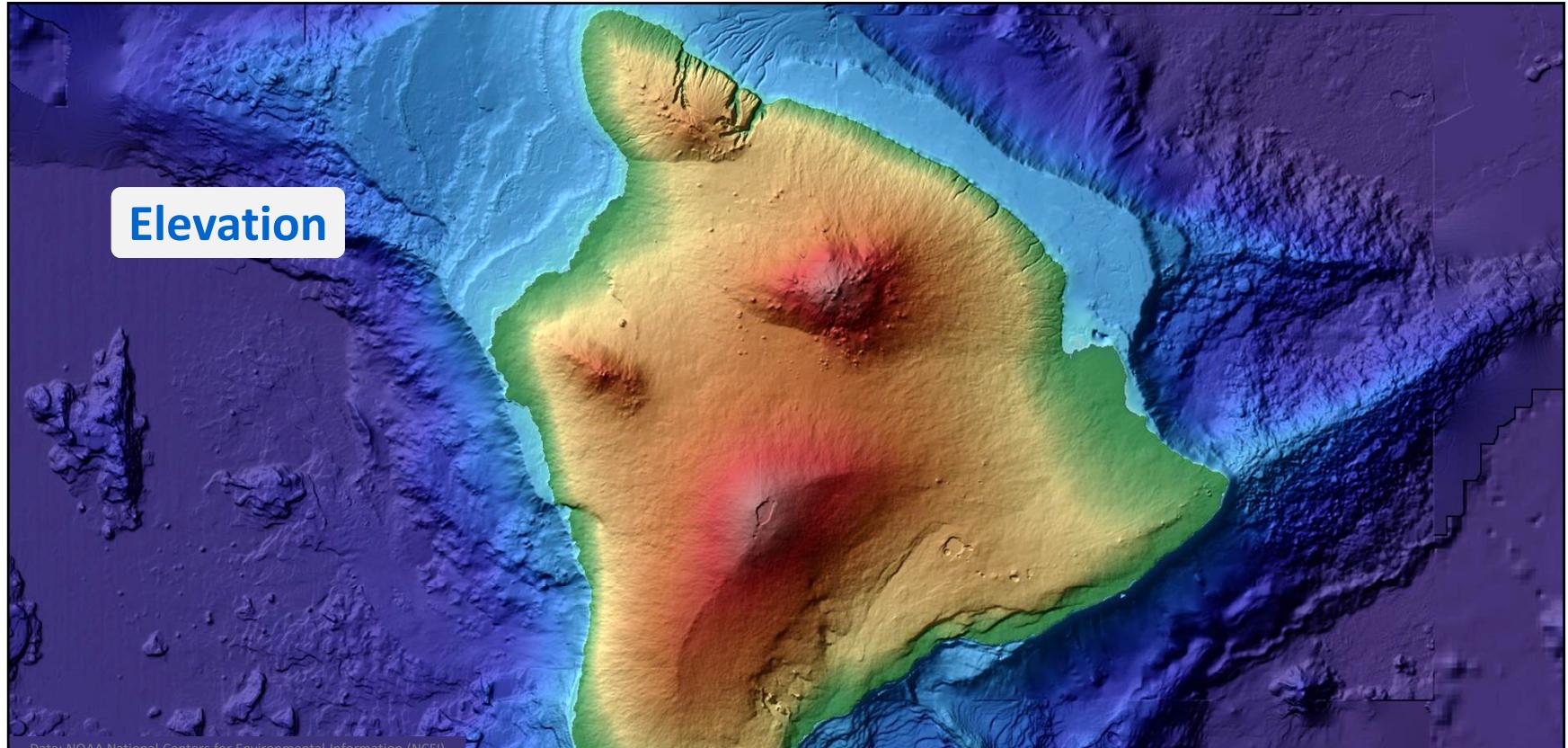


Objective: mapping things





Conceptualizing the real world



Continuous phenomena

Legend

Emergency Shelters



Volcanoes

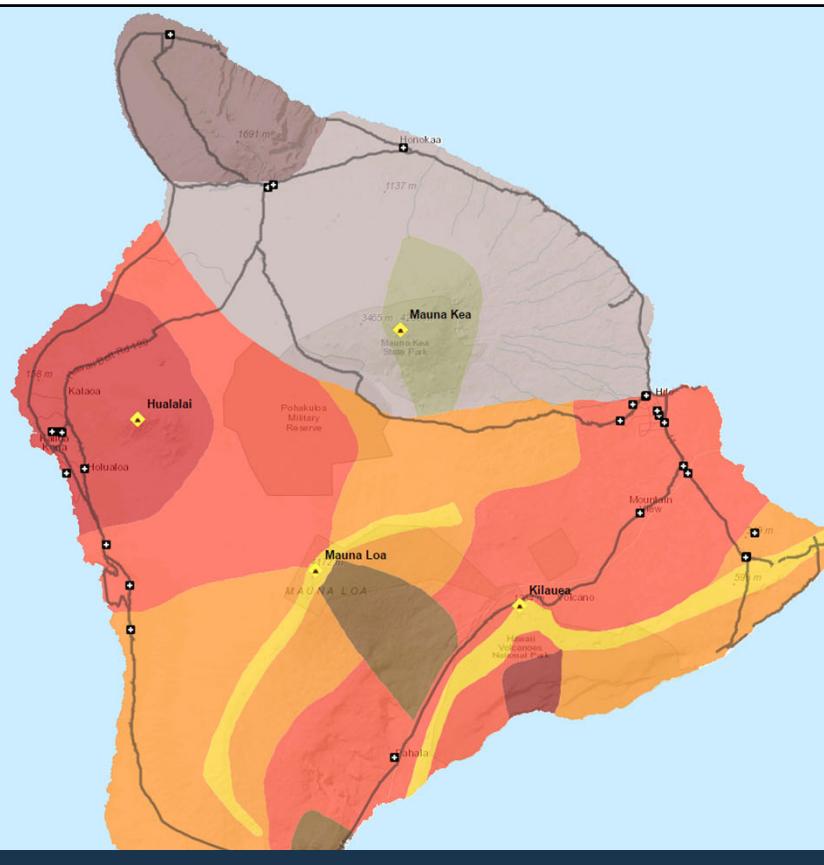


Highways



Lava Flow Hazard Zones

- Yellow: Extremely High Hazard
- Orange: Very High Hazard
- Red: High Hazard
- Brownish-red: Medium-High Hazard
- Brown: Medium Hazard
- Brownish-orange: Medium-Low Hazard
- Light brown: Low Hazard
- Pale brown: Very Low Hazard
- Dark brown: Extremely Low Hazard

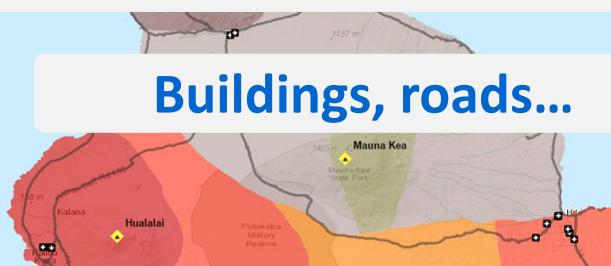


Discrete objects

Real world features exist as...

Discrete objects

Buildings, roads...



Continuous phenomena

Elevation, temperature...



How can these be shown on a digital map?

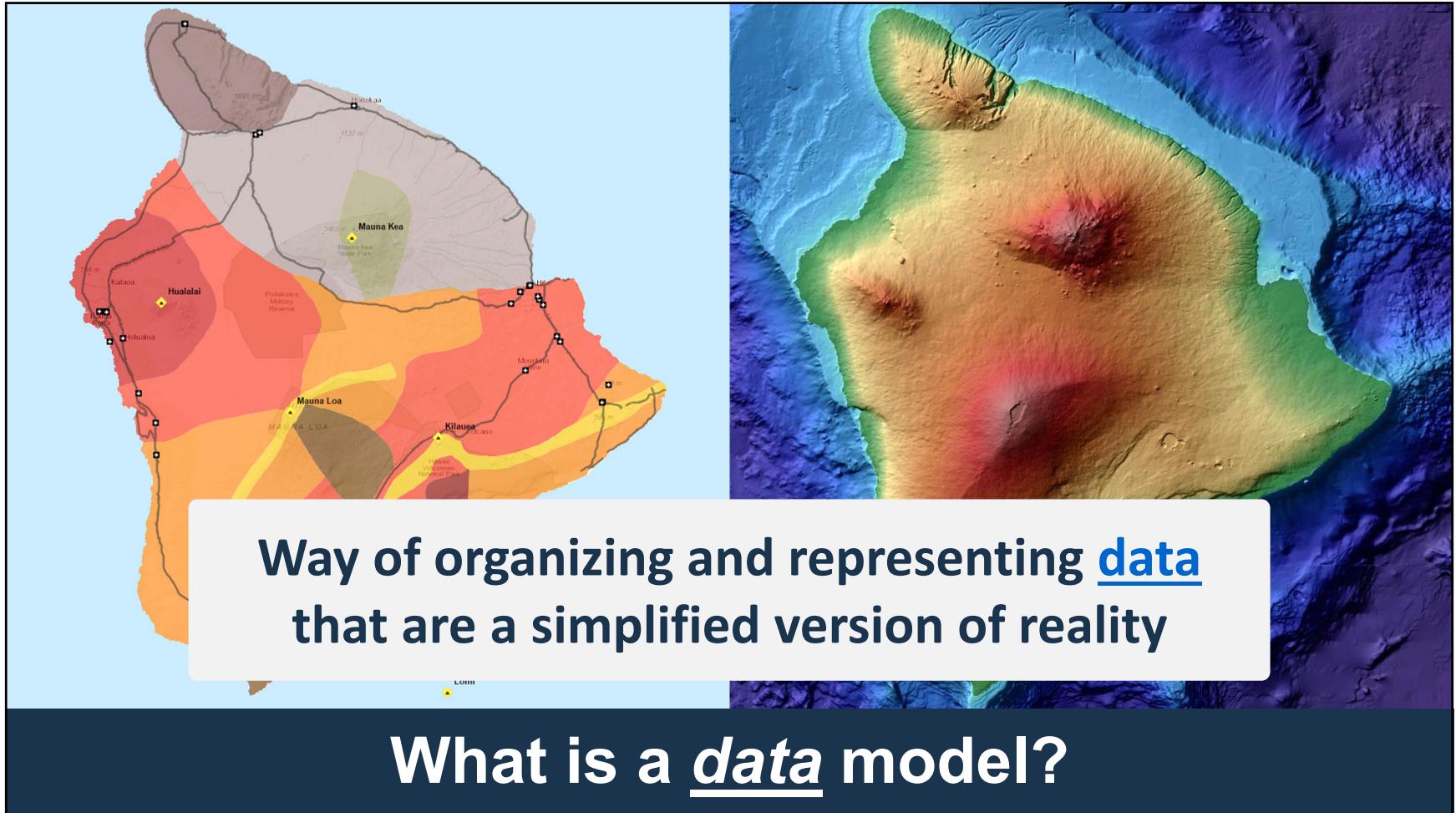
How can we store data about them?

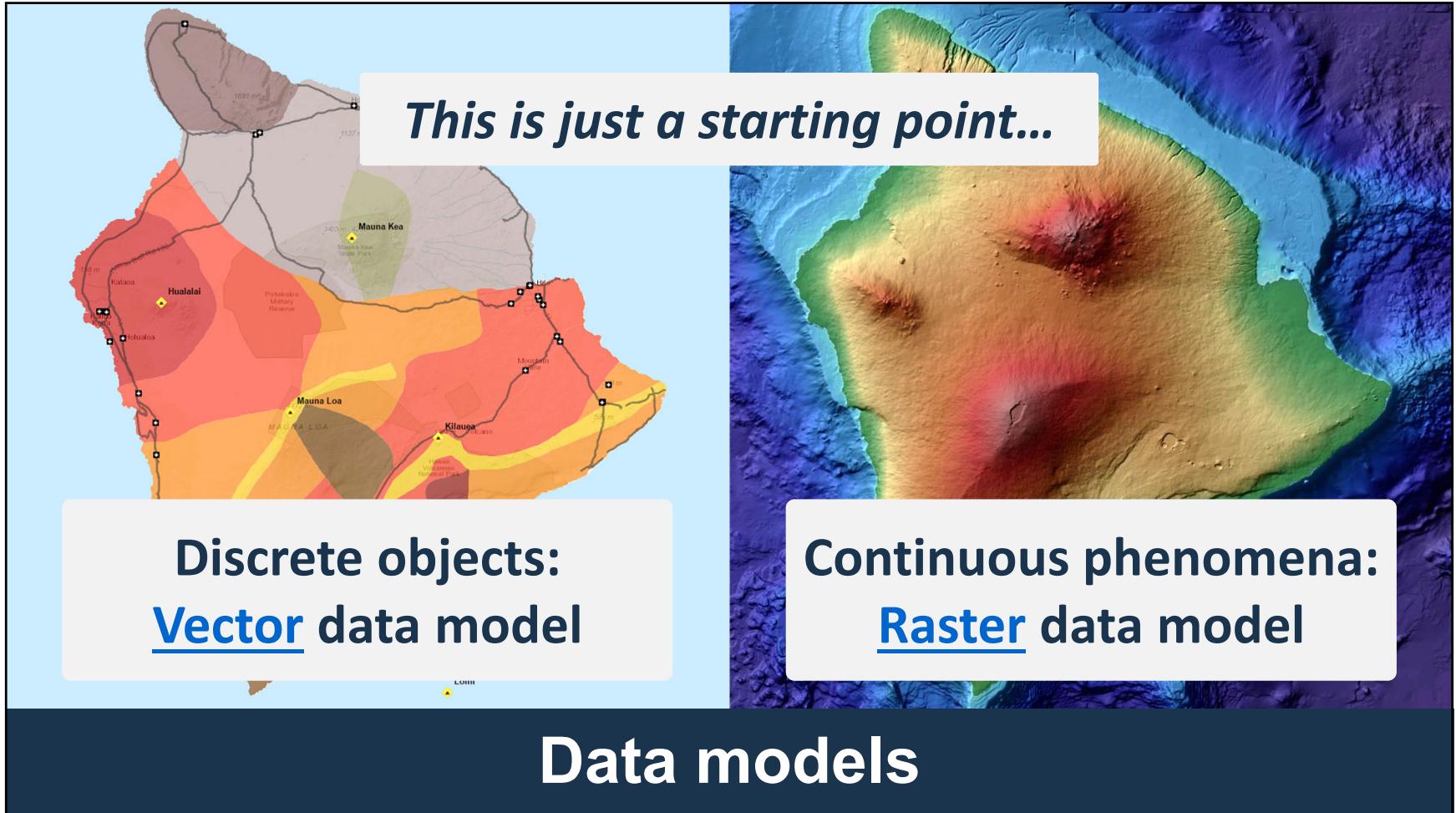
Use models.



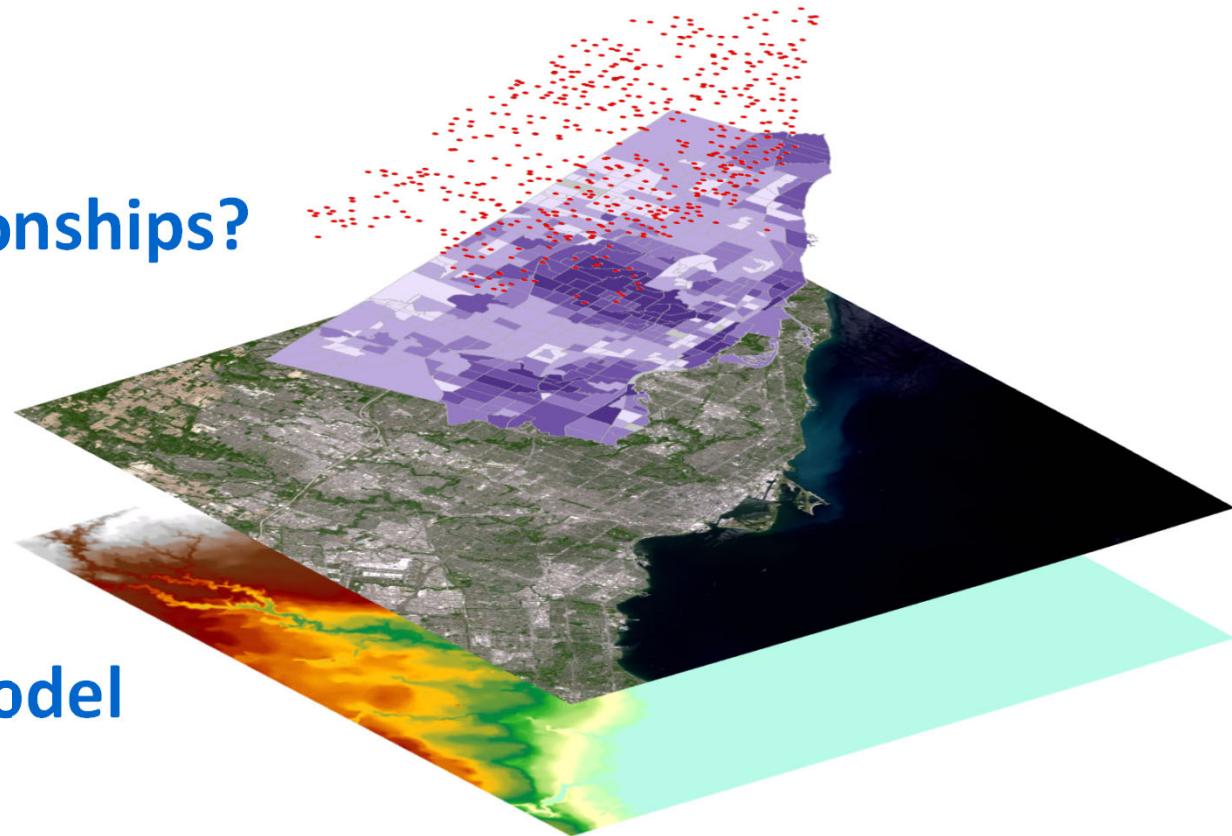
Simplified version of reality

What is a model?





Relationships?

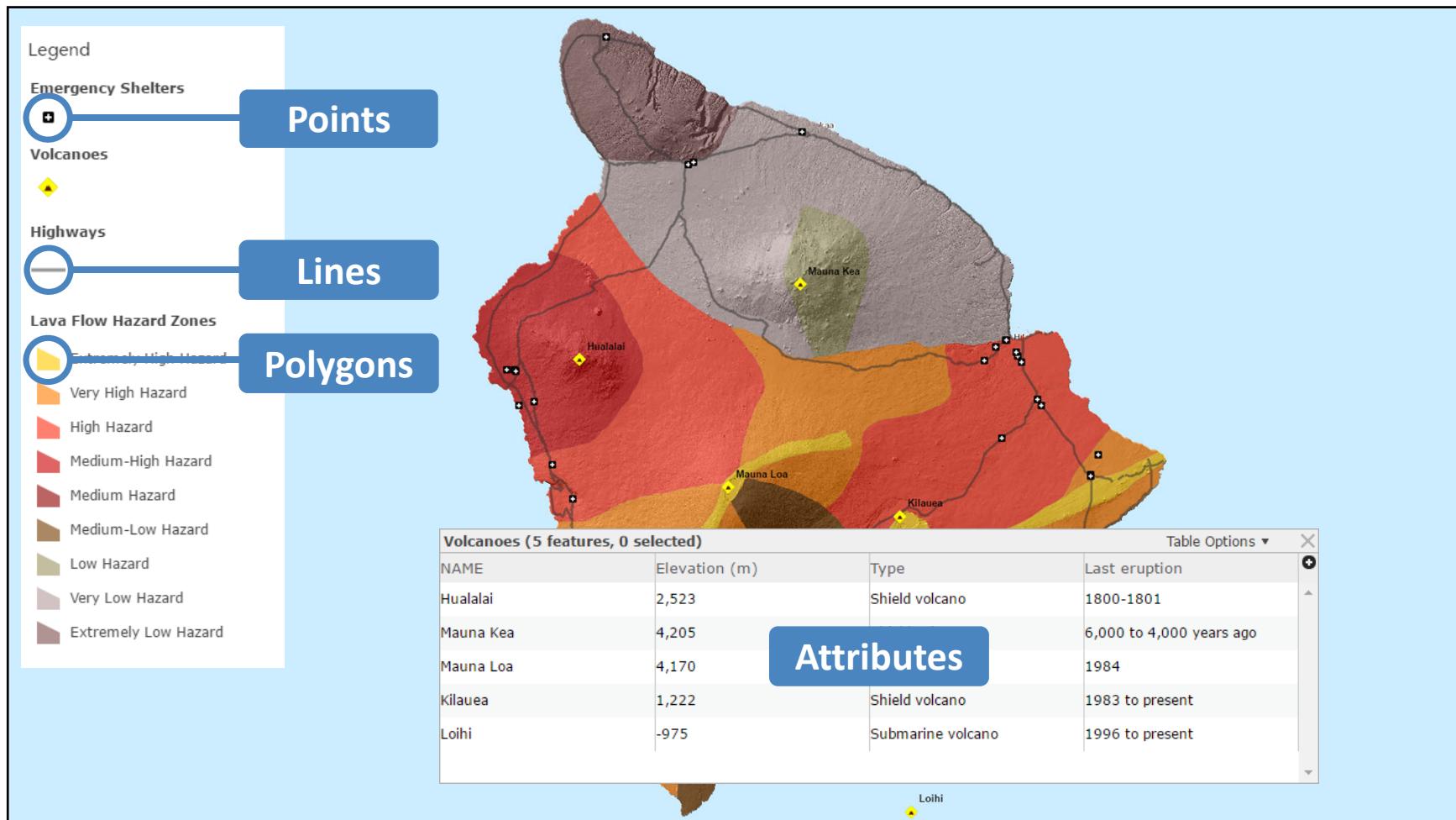


Model

Each map layer is a geographic theme

Vector data model





Geometry

point

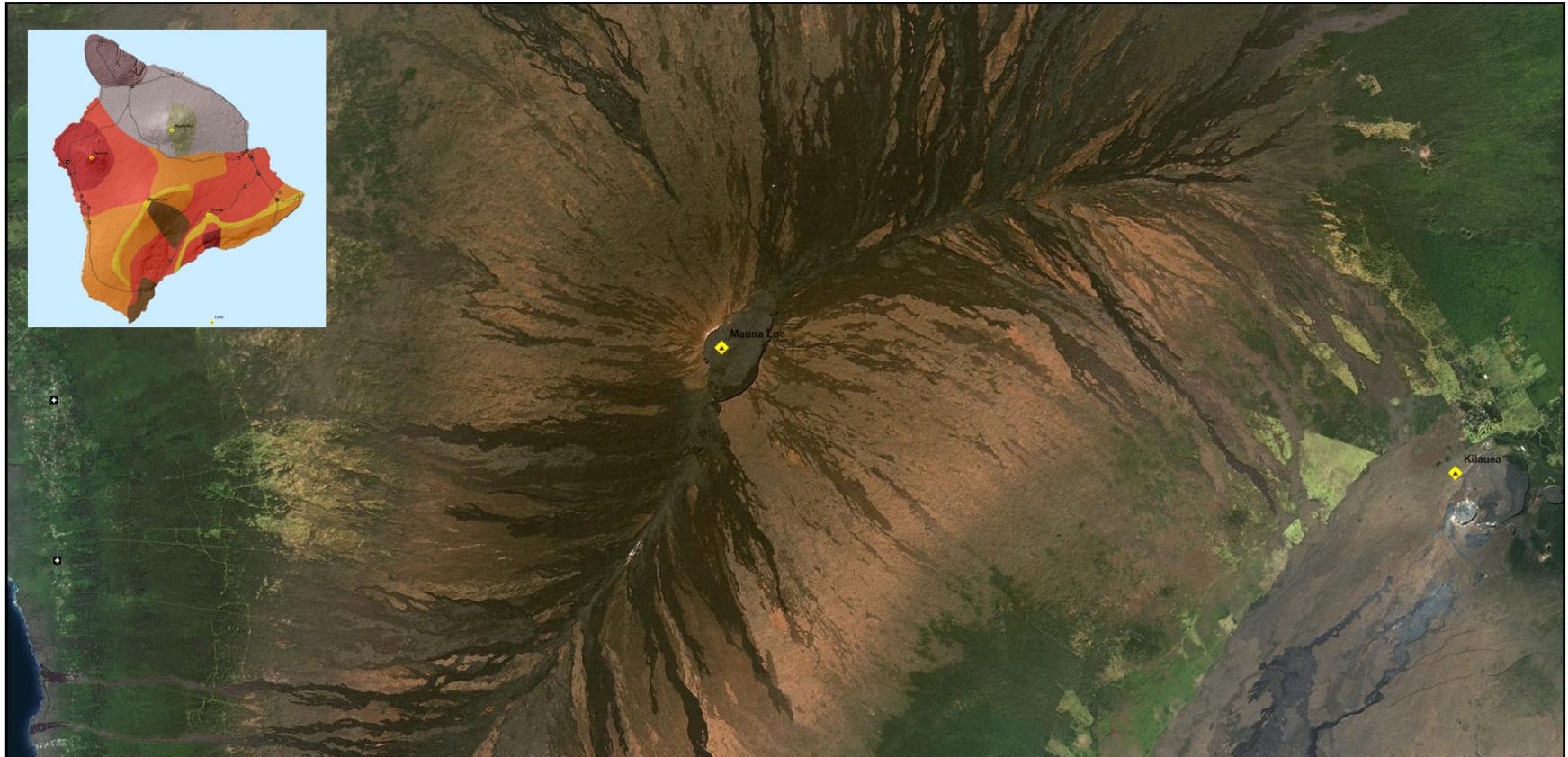
line

polygon

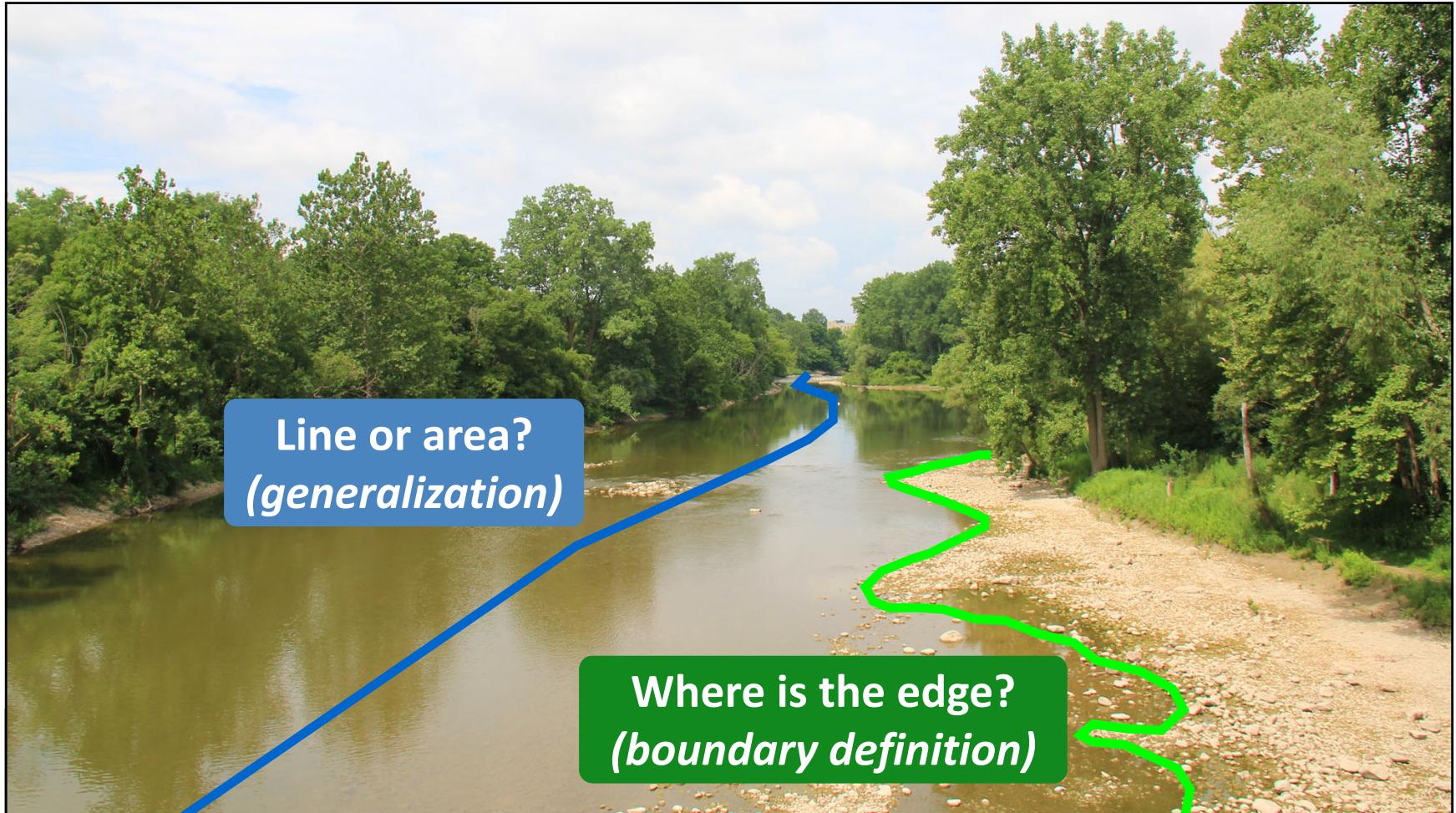
Attributes

Name	Speed Limit
Bloor Street West	50
University Record	Field
St. George Street	40
College Street	50

Vector data model



Scale and representation



Hawaii Island Lava Flow Risk

Explore a map of lava flow hazard zones on the island of Hawaii.

Web Map by Learn_ArcGIS
Last Modified: January 22, 2015
★★★☆☆ (1 rating, 43,849 views)
Facebook Twitter

OPEN SHARE

Description

The boundaries and classification of lava flow hazard zones on Hawaii Island. The map provides the island into nine hazard zones that are ranked from 1 through 9 based on the probability of coverage of the area by lava during a future eruption. Many of these zones are associated with areas where there are written records or that are known from the oral traditions of the Hawaiians.

Much of the USGS work was based on a study called [Geologic Map of the Island of Hawaii](#).

This map is part of the project [Get Started with ArcGIS Online](#) on the Learning Geo website.

Access and Use Constraints

None.

Map Contents

Emergency Shelters:
http://services2.arcgis.com/j80Jz20at6Bj0thr/arcgis/rest/services/Hawaii_Emergency_Shelters/FeatureServer/0

Volcanoes:
<http://services2.arcgis.com/j80Jz20at6Bj0thr/arcgis/rest/services/Volcanoes/FeatureServer/0>

Highways:
<http://services2.arcgis.com/j80Jz20at6Bj0thr/arcgis/rest/services/MajorHighways/FeatureServer/0>

Lava Flow Hazard Zones:
<http://services2.arcgis.com/j80Jz20at6Bj0thr/arcgis/rest/services/HawaiiLavaFlowHazardZones/FeatureServer/0>

Terrain:
<http://tiles.arcgis.com/tiles/j80Jz20at6Bj0thr/arcgis/rest/services/Hillshade/MapServer>

Topographic:
http://services.arcgisonline.com/ArcGIS/rest/services/World_Topo_Map/MapServer

Legend

Emergency Shelters

- +

Volcanoes

- ◆

Highways

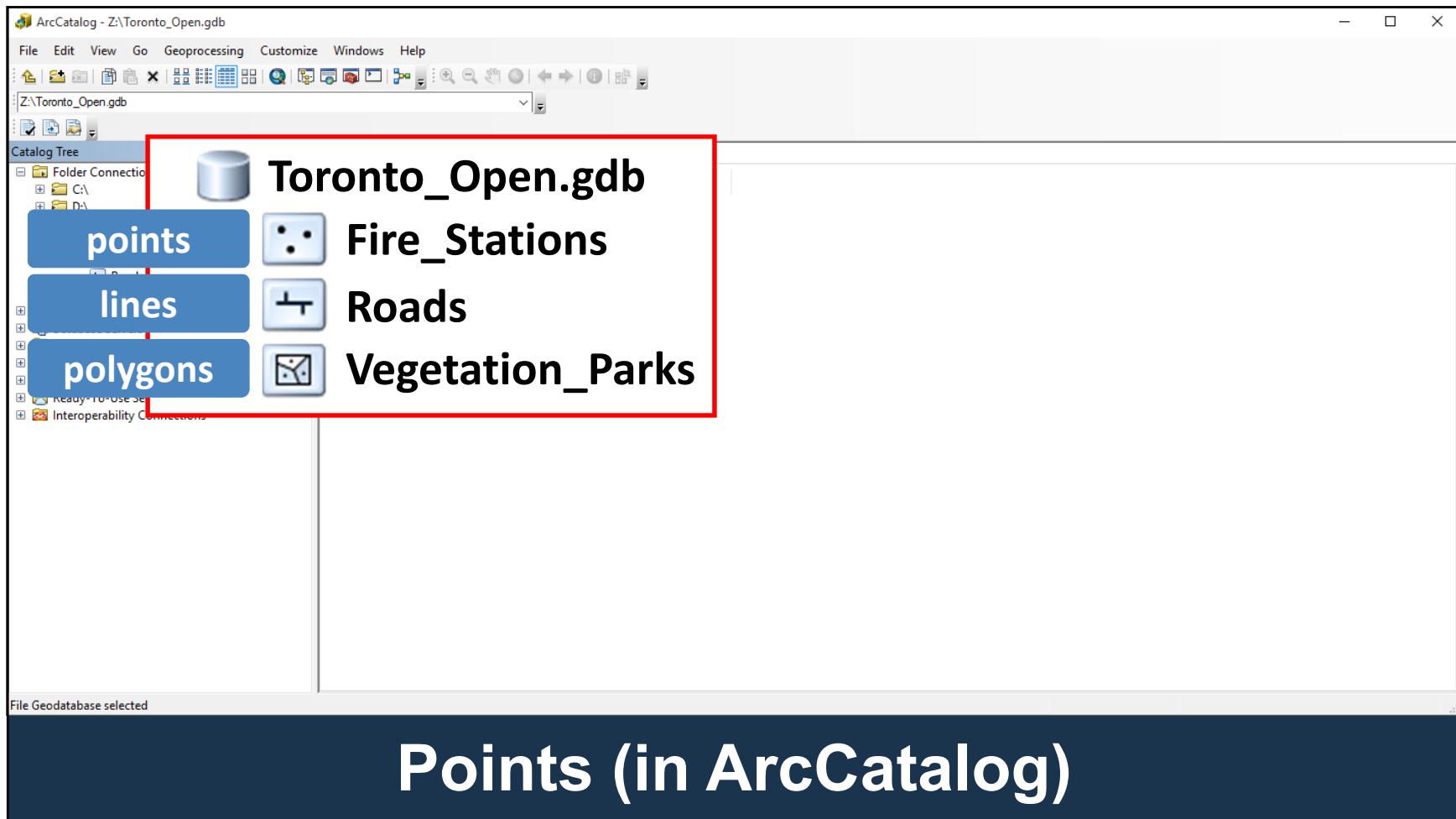
-

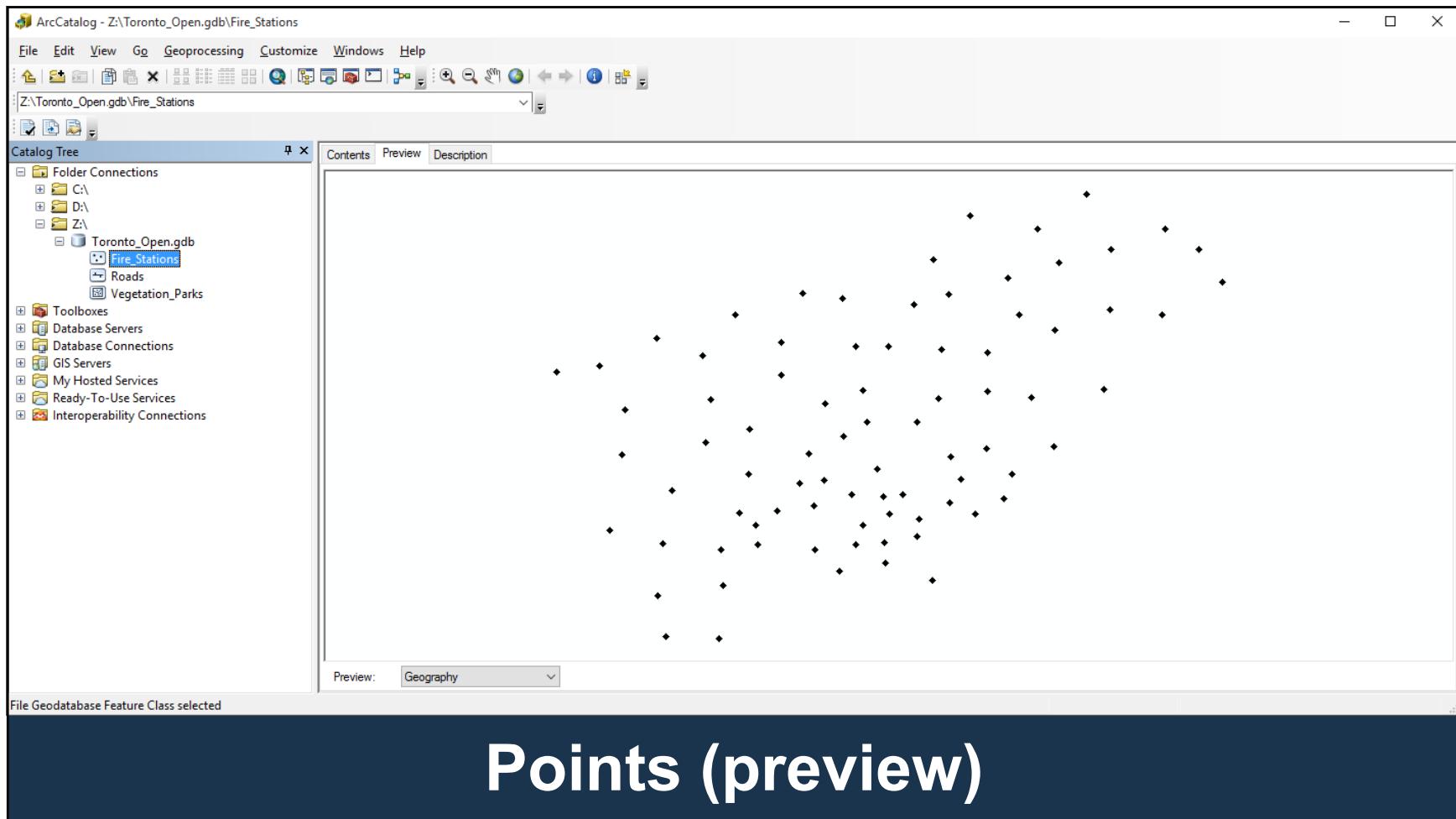
Lava Flow Hazard Zones

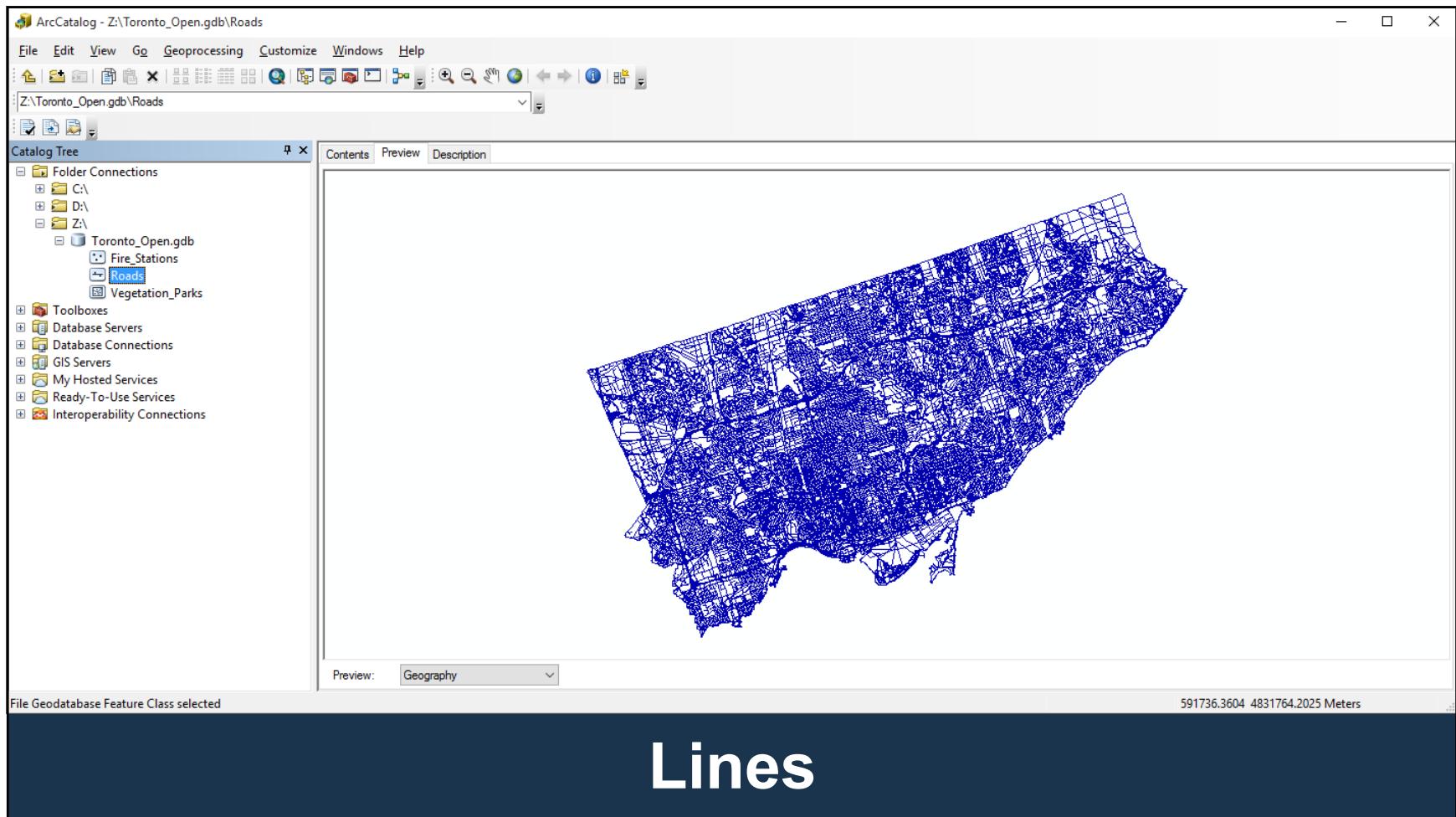
- Extremely High Hazard
- Very High Hazard
- High Hazard
- Medium-High Hazard
- Medium Hazard
- Medium-Low Hazard
- Low Hazard
- Very Low Hazard
- Extremely Low Hazard

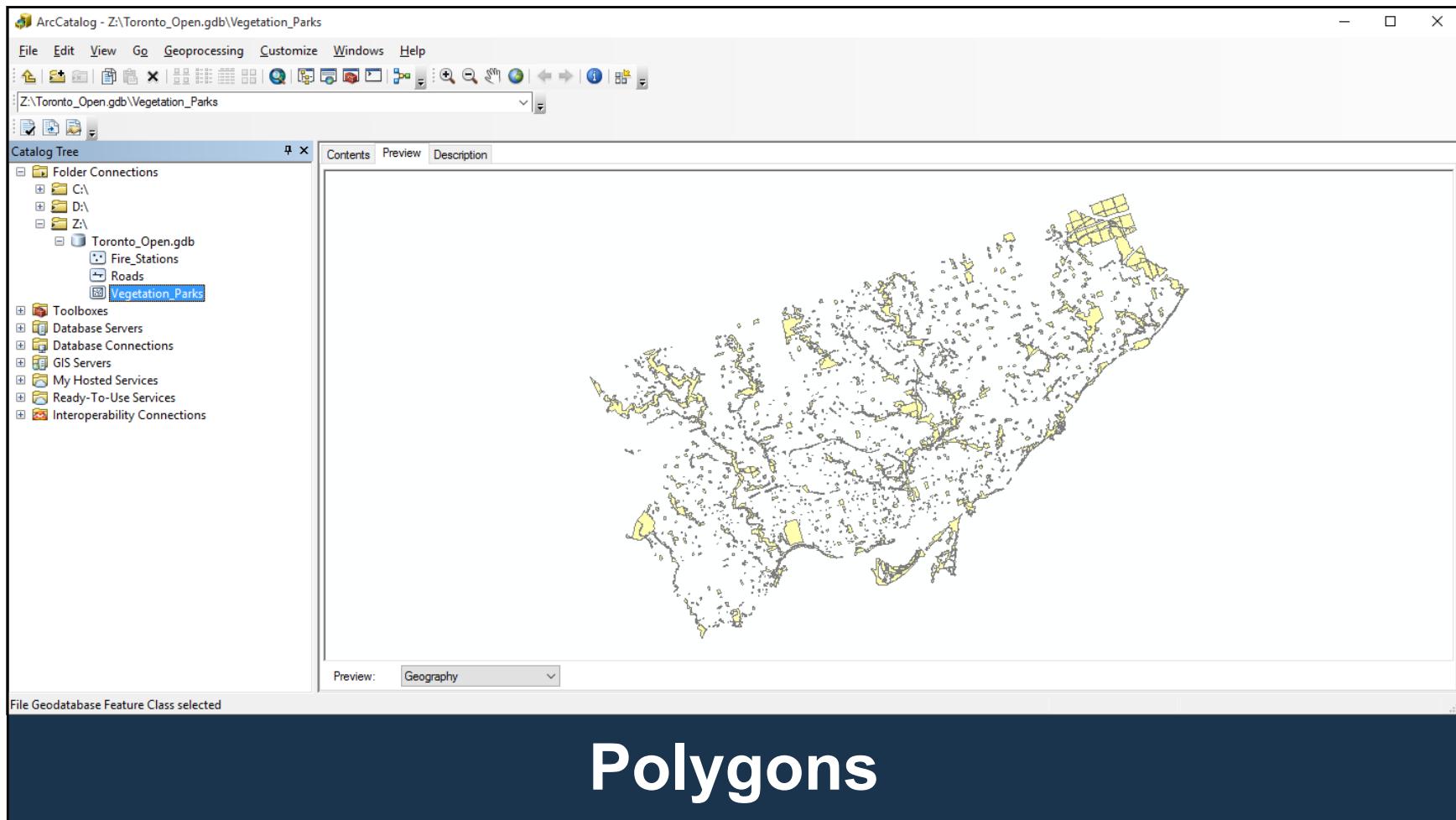
Points, lines, and polygons are not stored in the same map layer

Each map layer contains only one theme









ArcCatalog - Z:\Toronto_Open.gdb\Vegetation_Parks

File Edit View Go Geoprocessing Customize Windows Help

Z:\Toronto_Open.gdb\Vegetation_Parks

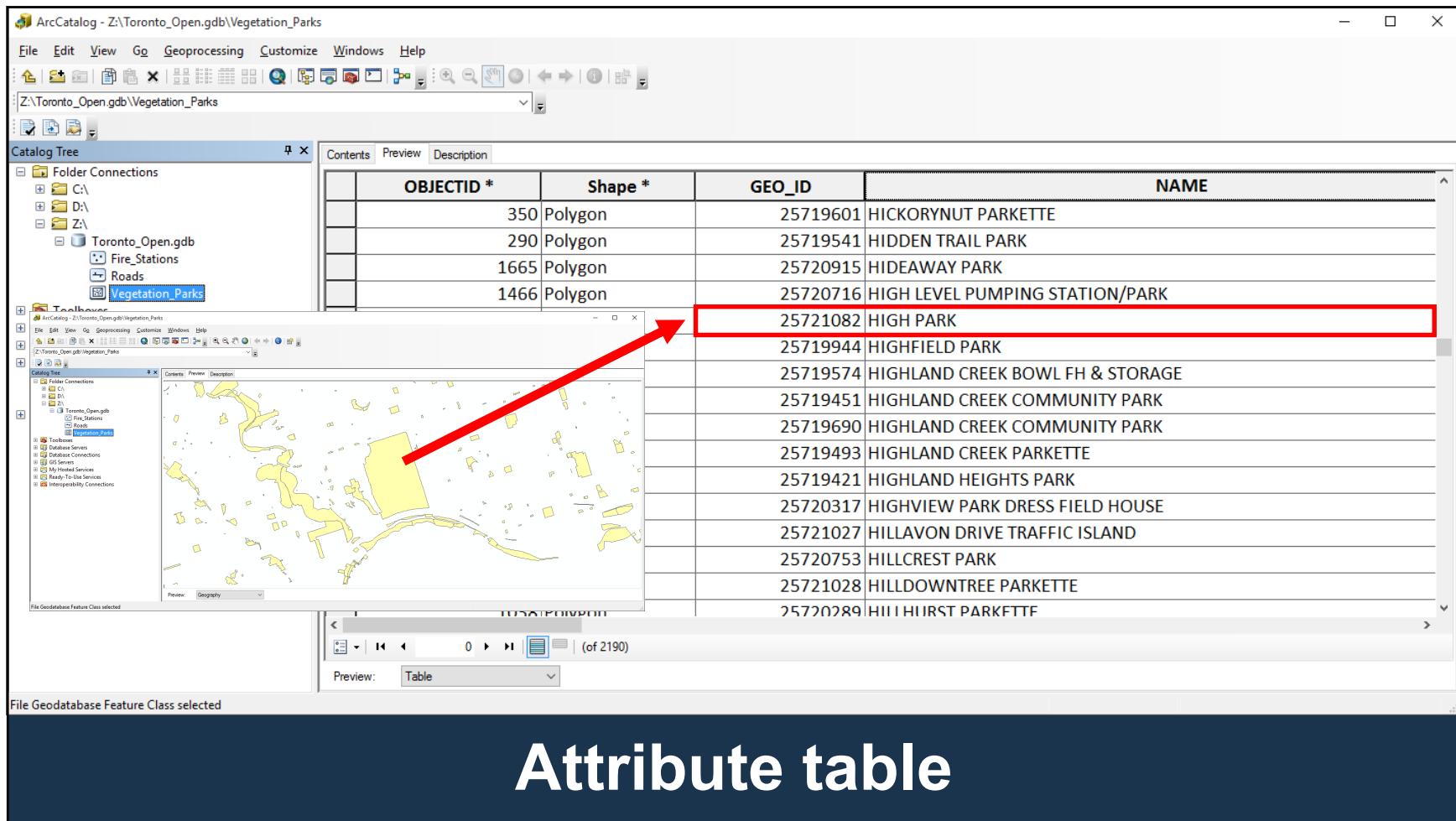
Catalog Tree

Contents Preview Description

OBJECTID *	Shape *	GEO_ID	NAME
350	Polygon	25719601	HICKORYNUT PARKETTE
290	Polygon	25719541	HIDDEN TRAIL PARK
1665	Polygon	25720915	HIDEAWAY PARK
1466	Polygon	25720716	HIGH LEVEL PUMPING STATION/PARK
25721082	Polygon	25721082	HIGH PARK
25719944	Polygon	25719944	HIGHFIELD PARK
25719574	Polygon	25719574	HIGHLAND CREEK BOWL FH & STORAGE
25719451	Polygon	25719451	HIGHLAND CREEK COMMUNITY PARK
25719690	Polygon	25719690	HIGHLAND CREEK COMMUNITY PARK
25719493	Polygon	25719493	HIGHLAND CREEK PARKETTE
25719421	Polygon	25719421	HIGHLAND HEIGHTS PARK
25720317	Polygon	25720317	HIGHVIEW PARK DRESS FIELD HOUSE
25721027	Polygon	25721027	HILLAVON DRIVE TRAFFIC ISLAND
25720753	Polygon	25720753	HILLCREST PARK
25721028	Polygon	25721028	HILLDOWNTREE PARKETTE
25720289	Polygon	25720289	HILL FIRST PARKETTE

File Geodatabase Feature Class selected

Attribute table



A screenshot of the ArcCatalog application interface. The title bar reads "ArcCatalog - Z:\Toronto_Open.gdb". The menu bar includes File, Edit, View, Go, Geoprocessing, Customize, Windows, and Help. The toolbar has various icons for file operations. A Catalog Tree pane on the left shows "Folder Connections" with drives C:\, D:\, and Z:\. Under Z:\, "Toronto_Open.gdb" is selected, revealing its contents: "Fire_Stations", "Roads", and "Vegetation_Parks". A red box highlights these three items. To the right is a "Contents" pane with tabs for "Contents", "Preview", and "Description". It lists the three feature classes with their types: "Fire_Stations" (File Geodatabase Feature Class), "Roads" (File Geodatabase Feature Class), and "Vegetation_Parks" (File Geodatabase Feature Class). A red arrow points from the "Toronto_Open.gdb" entry in the Catalog Tree to the "Contents" pane. Below the Catalog Tree, a large blue callout box contains the text: "Geodatabase (.gdb)" with an icon of a cylinder. To the right of the callout, another blue callout box contains the text: "In ArcGIS, points, lines, & polygons are stored in separate map layers called feature classes".

Geodatabase (.gdb)

In ArcGIS, points, lines, & polygons are stored in separate map layers called feature classes

Geodatabase and feature classes

feature class - GIS Dictionary X

support.esri.com/en/knowledgebase/GISDictionary/search

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Support

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GIS Dictionary

Definitions for GIS terms related to operations such as analysis, GIS modeling and web-based GIS, cartography, and Esri software.

Now available for purchase: [A to Z GIS: An illustrated dictionary of geographic information systems](#).

Search the GIS Dictionary:

Browse the GIS Dictionary: # A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

feature class
See Also : [object class](#)

1. [ESRI software] In ArcGIS, a collection of geographic features with the same geometry type (such as point, line, or polygon), the same attributes, and the same spatial reference. Feature classes can be stored in geodatabases, shapefiles, coverages, or other data formats. Feature classes allow homogeneous features to be grouped into a single unit for data storage purposes. For example, highways, primary roads, and secondary roads can be grouped into a line feature class named "roads." In a geodatabase, feature classes can also store annotation and dimensions.



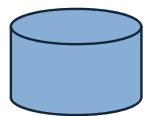
[Link](#)

GIS Bibliography
Researching GIS?
Search the GIS Bibliography for a vast index of books, journals, conference proceedings and reports.

Feature class

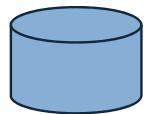
- One data type
 - ◆ can't mix points, lines, polygons in same file
- One theme
 - ◆ e.g., just provinces, or just lakes, not both

Types of geodatabase



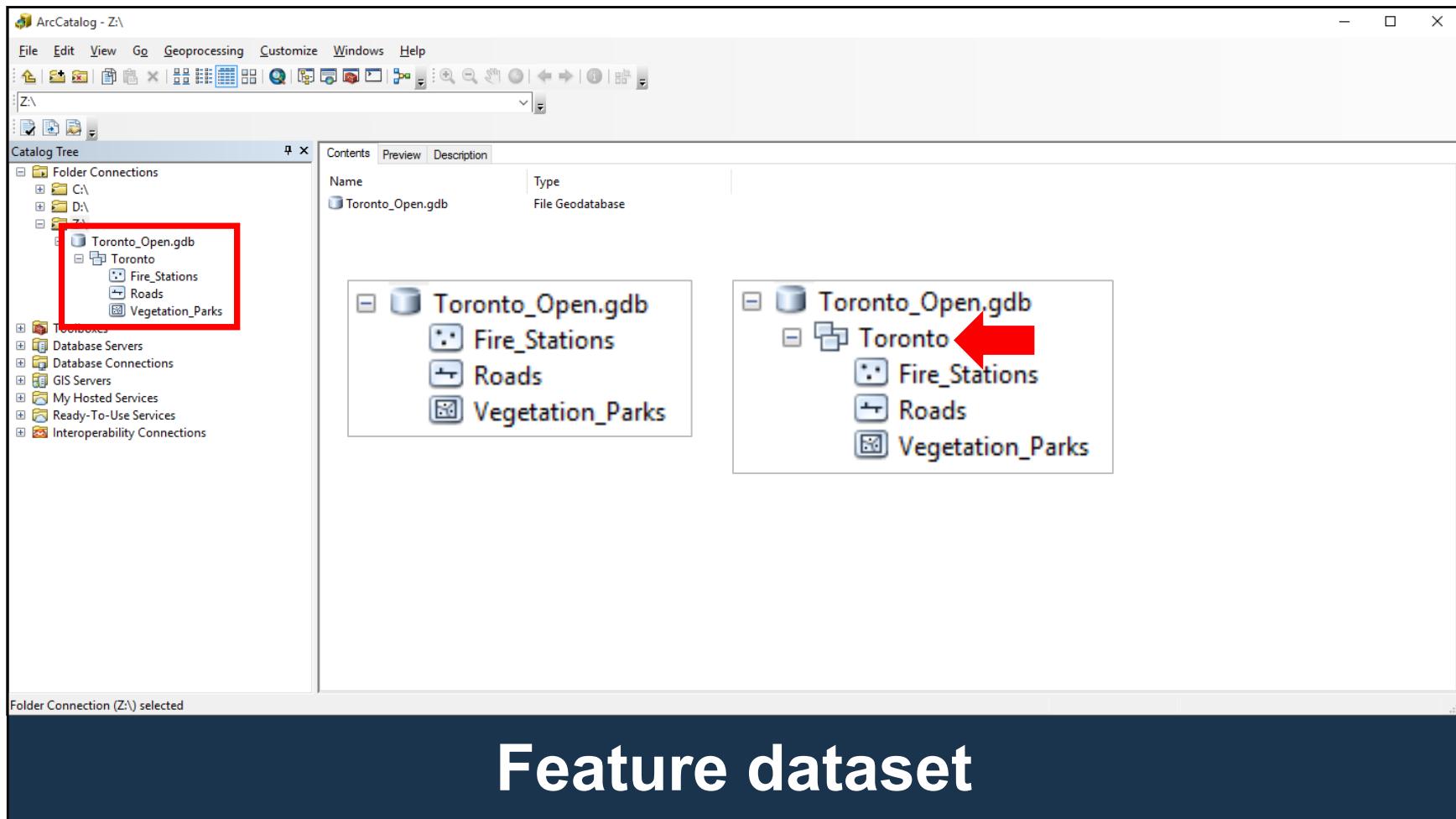
File geodatabase

- ◆ Newest file format (.gdb)
- ◆ Recommended by Esri
- ◆ Looks like a Windows folder (do not edit!)



Personal geodatabase

- ◆ Microsoft Access file format (.mdb)



The screenshot shows the ArcCatalog interface with two main panes. The left pane, 'Catalog Tree', displays a folder structure under 'Z:\'. A red box highlights the 'Toronto_Open.gdb' folder, which contains subfolders 'Toronto' and shapefiles 'Fire_Stations.shp', 'Roads.shp', and 'Vegetation_Parks.shp'. The right pane, 'Contents', shows the same data in a tabular format:

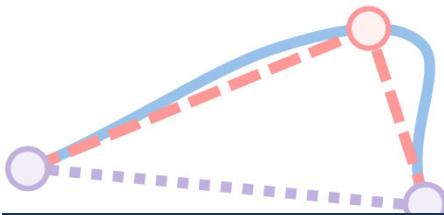
Name	Type
Toronto_Open.gdb	File Geodatabase
Fire_Stations.shp	Shapefile
Roads.shp	Shapefile
Vegetation_Parks.shp	Shapefile

A second table below it shows the same data again, with a red arrow pointing to the 'Type' column for the 'Fire_Stations.shp' entry, which is listed as a 'Shapefile'.

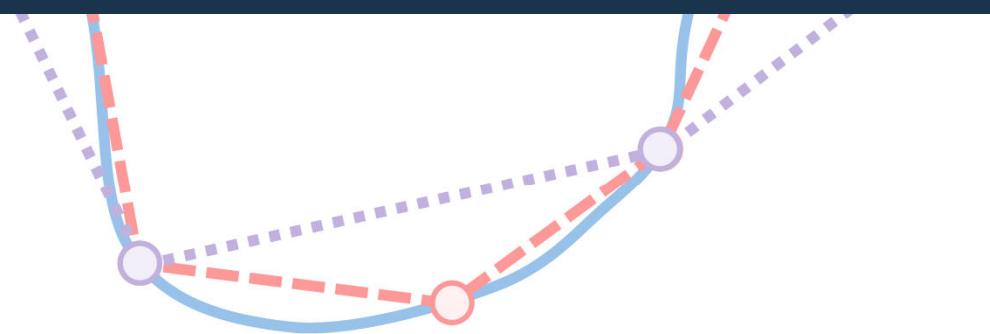
Same features and attributes, but stored in a different file format

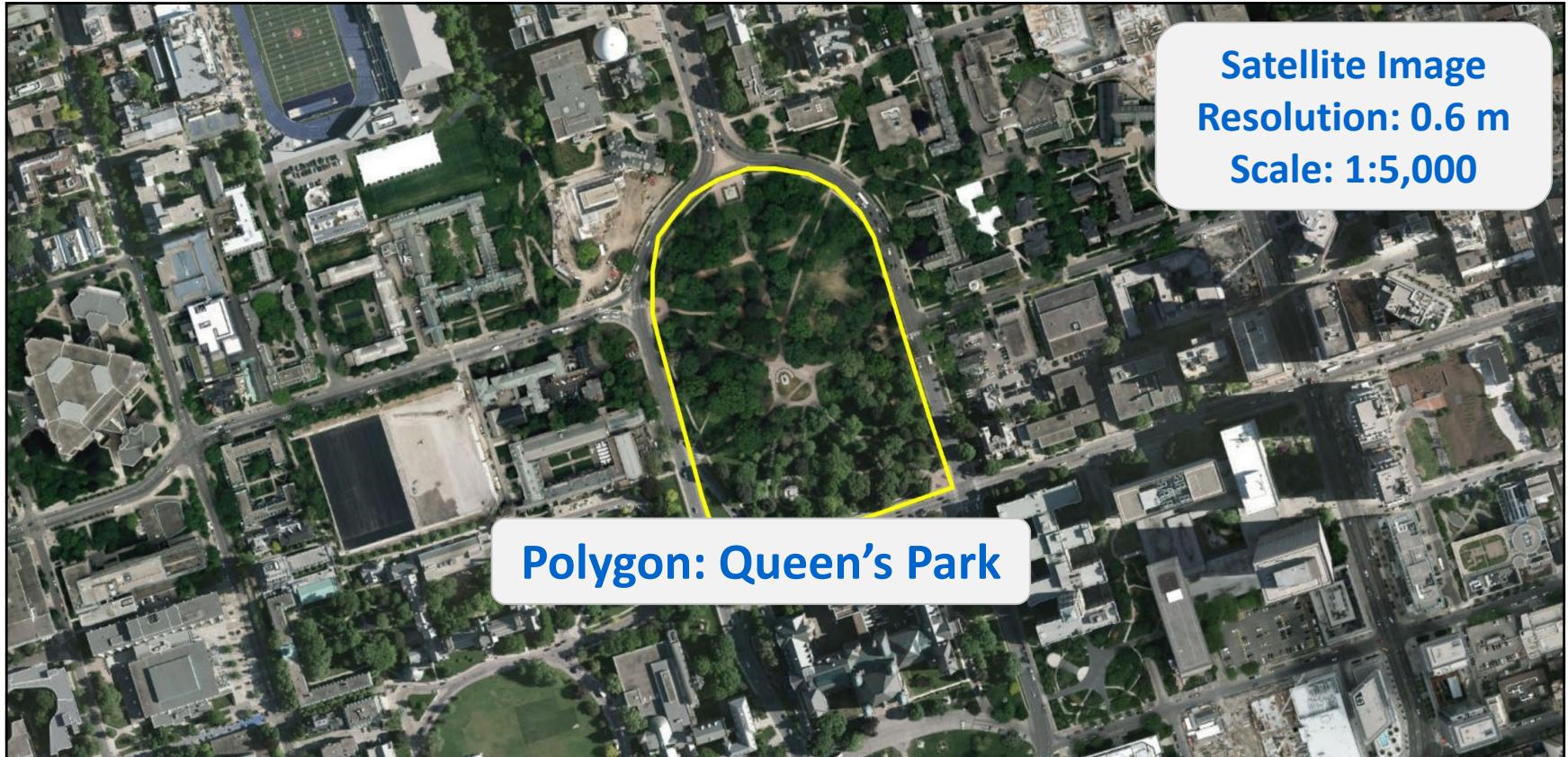
Shapefiles

Software:	ArcInfo	ArcView	ArcGIS
Developed:	1980s	1990s	2000s
Same data:	 	 	 
Data format:	 Coverage	 Shapefile	 Geodatabase
Topology required	Topology required	Topology absent	Topology optional
	Complicated	Simple	Sophisticated
	Hard to use	Easy to use	Easy to use
	Efficient data	Inefficient data	↑ Functionality



Sampling frequency for digitizing

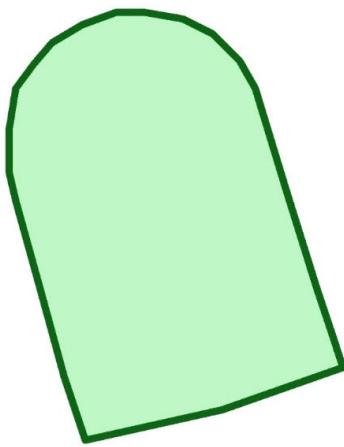




Satellite Image
Resolution: 0.6 m
Scale: 1:5,000

Polygon: Queen's Park

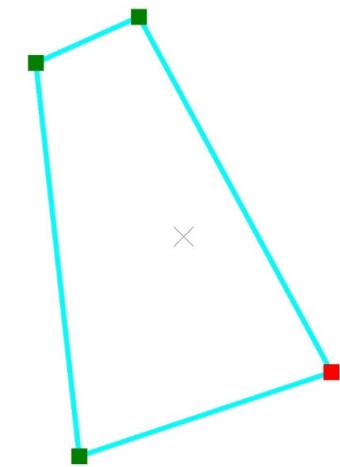
Digitizing a feature



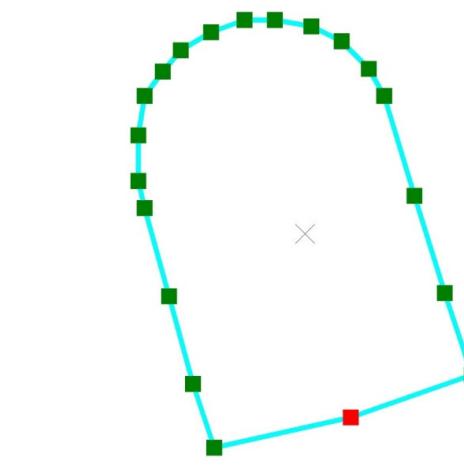
Satellite Image
Resolution: 0.6 m
Scale: 1:5,000

Polygon: Queen's Park

Digitizing a feature

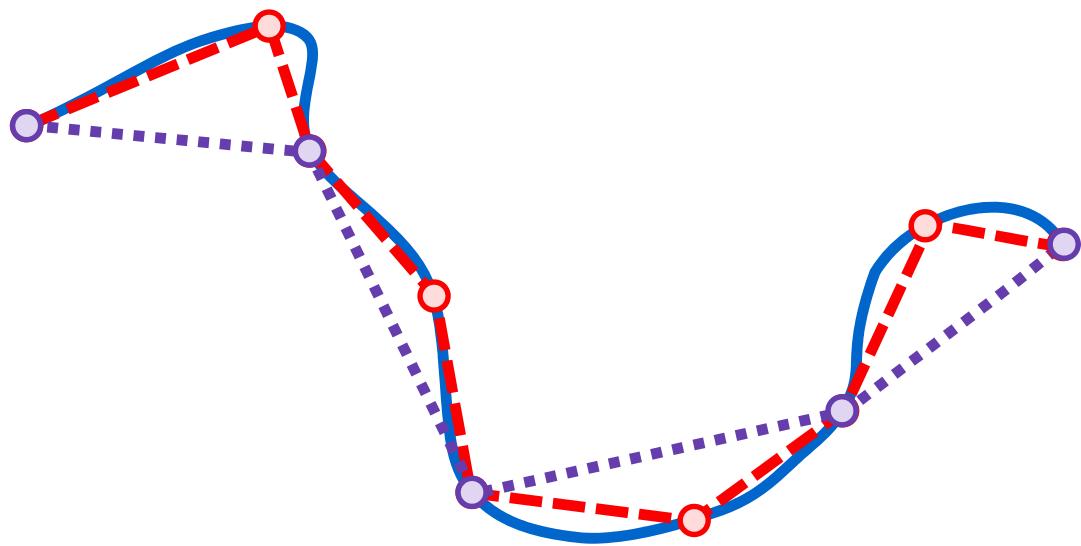


4 sample points



20 sample points

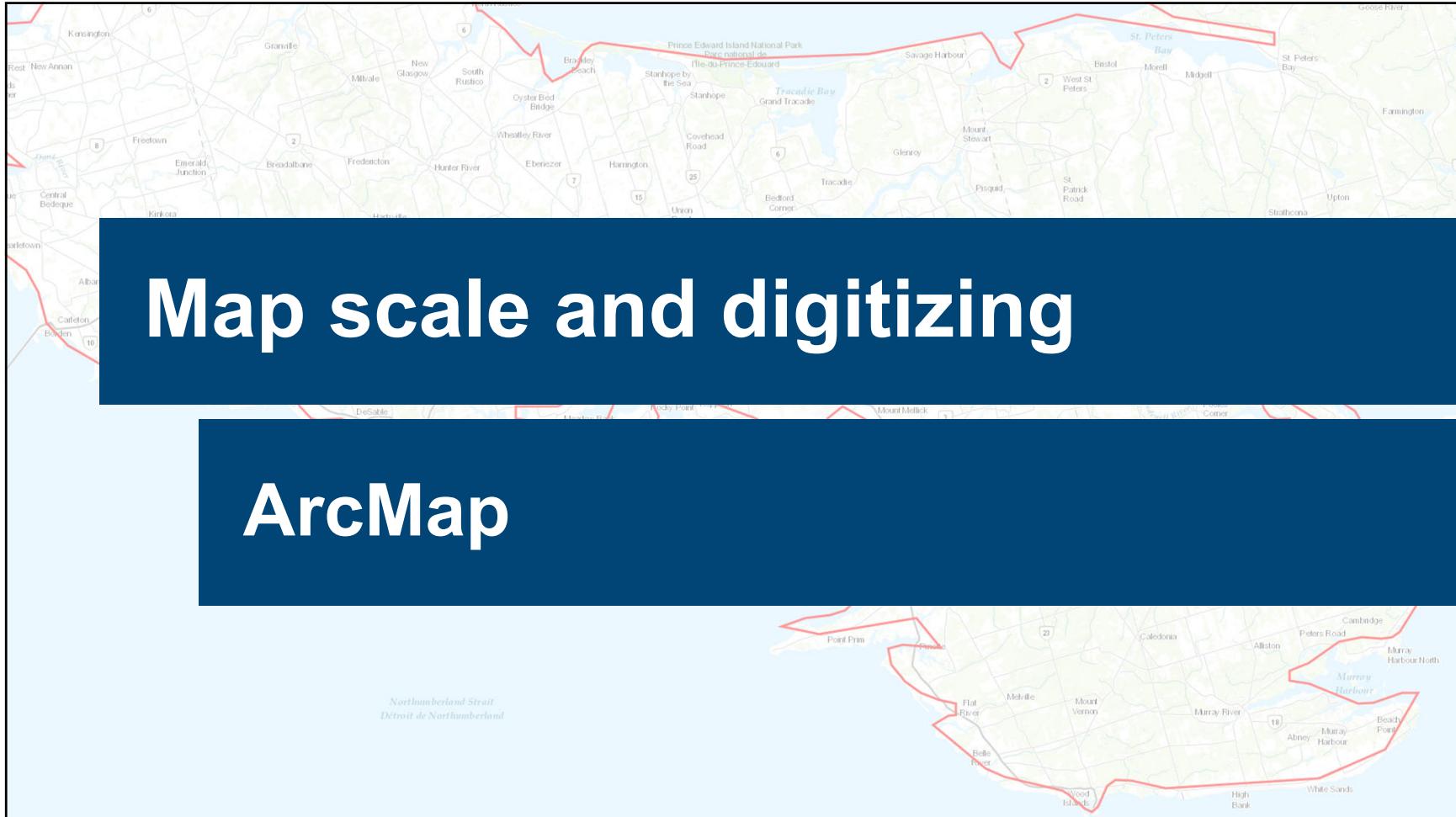
Sampling frequency?



Sampling frequency?

Sampling frequency

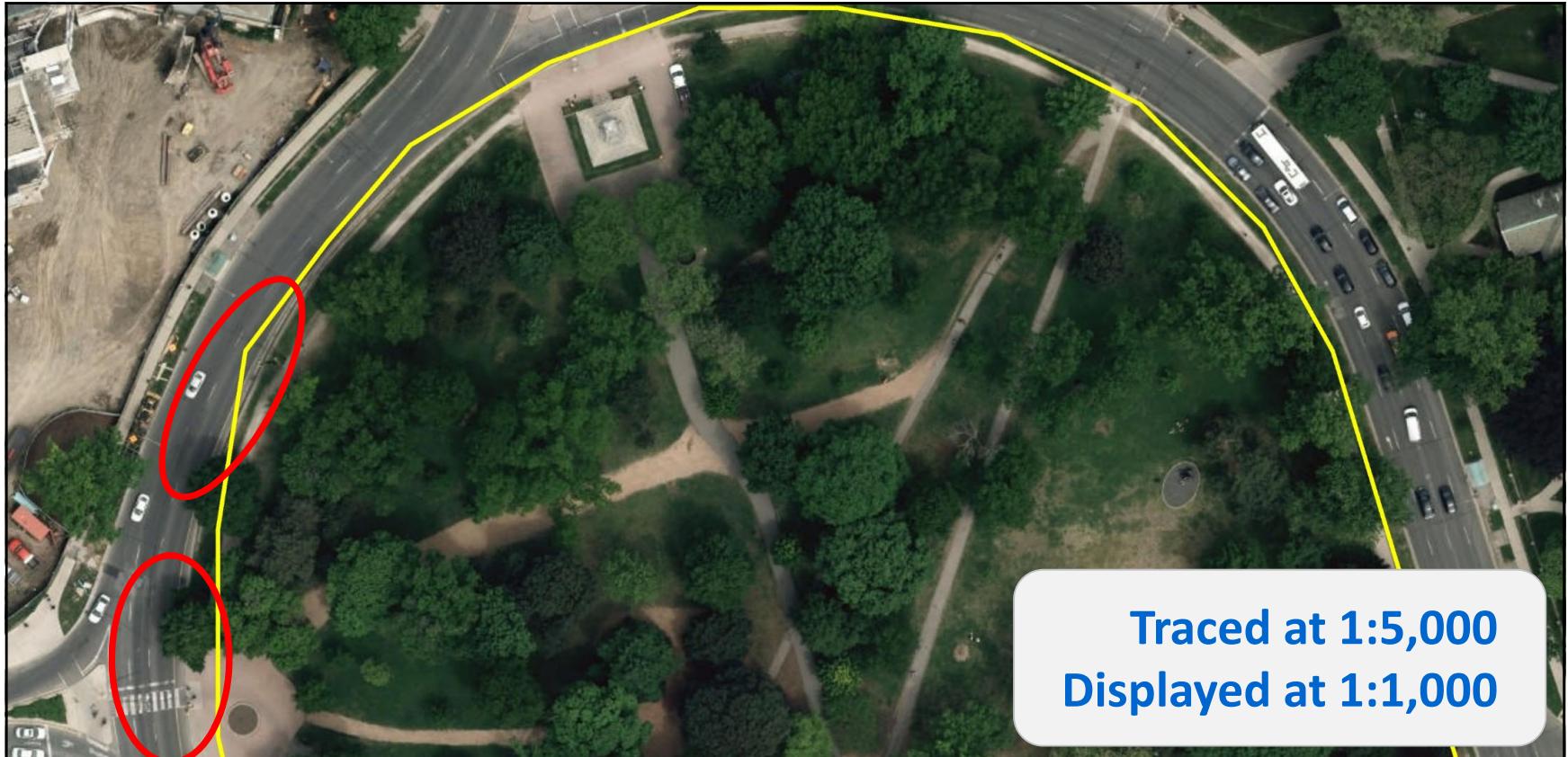
- Must capture desired level of detail
 - ◆ Too much:
 - Excess data volume
 - Slows down processing
 - Takes up storage space
 - ◆ Too little:
 - may not have enough data to complete your analysis
 - Poor accuracy.





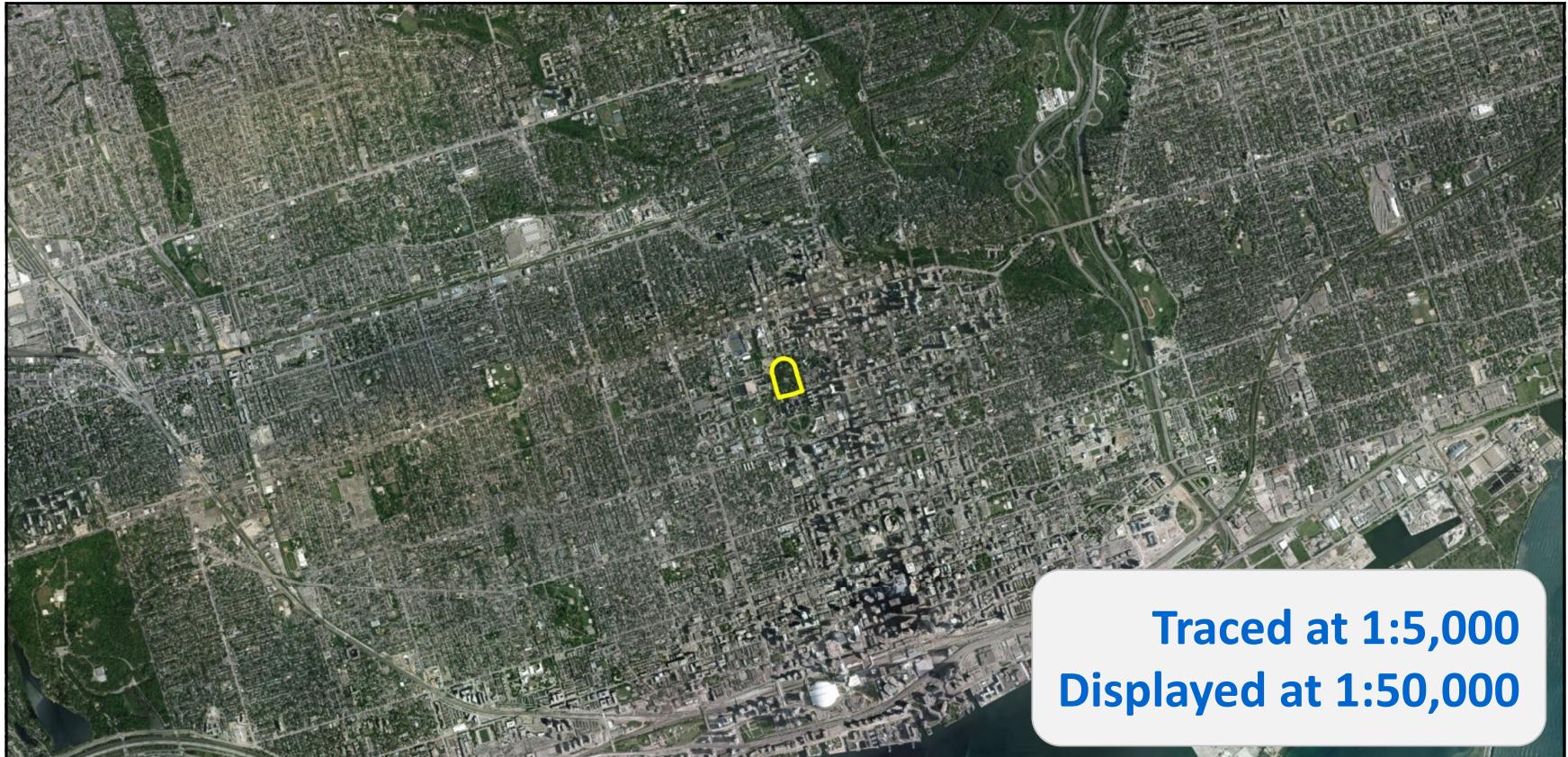
Traced at 1:5,000
Displayed at 1:5,000

What scale should be used when tracing?



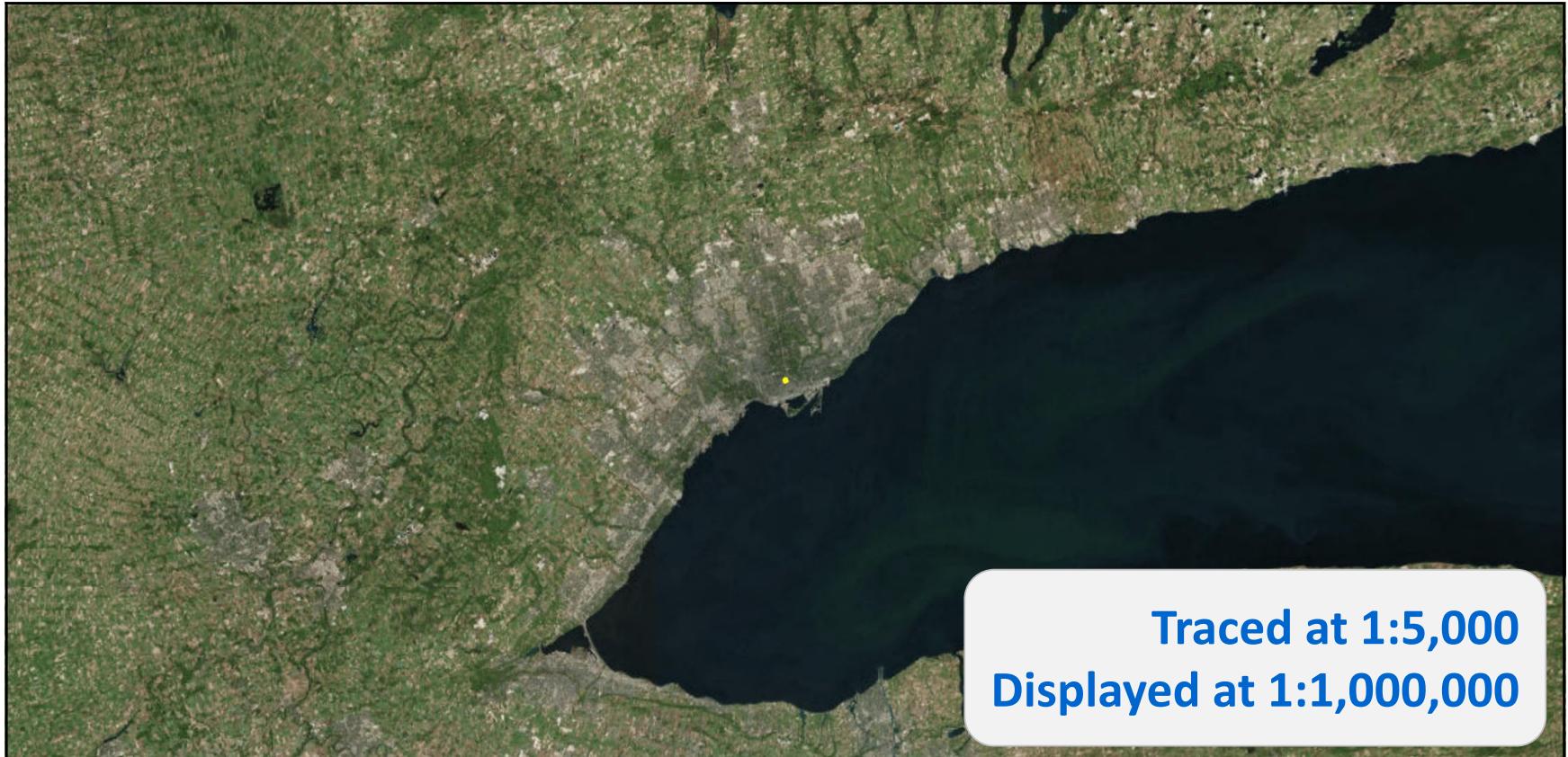
Traced at 1:5,000
Displayed at 1:1,000

Errors noticeable at larger map scales

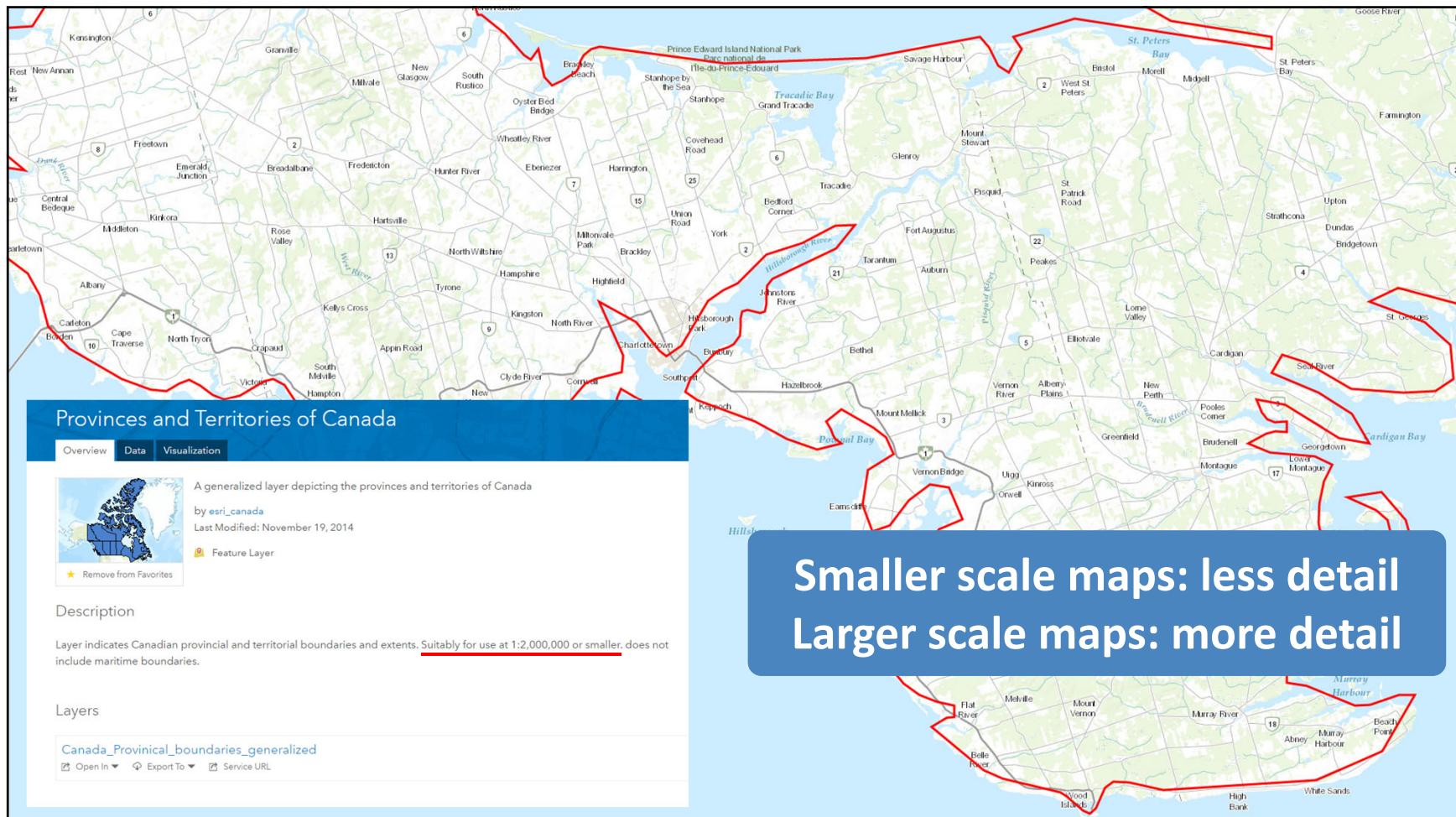


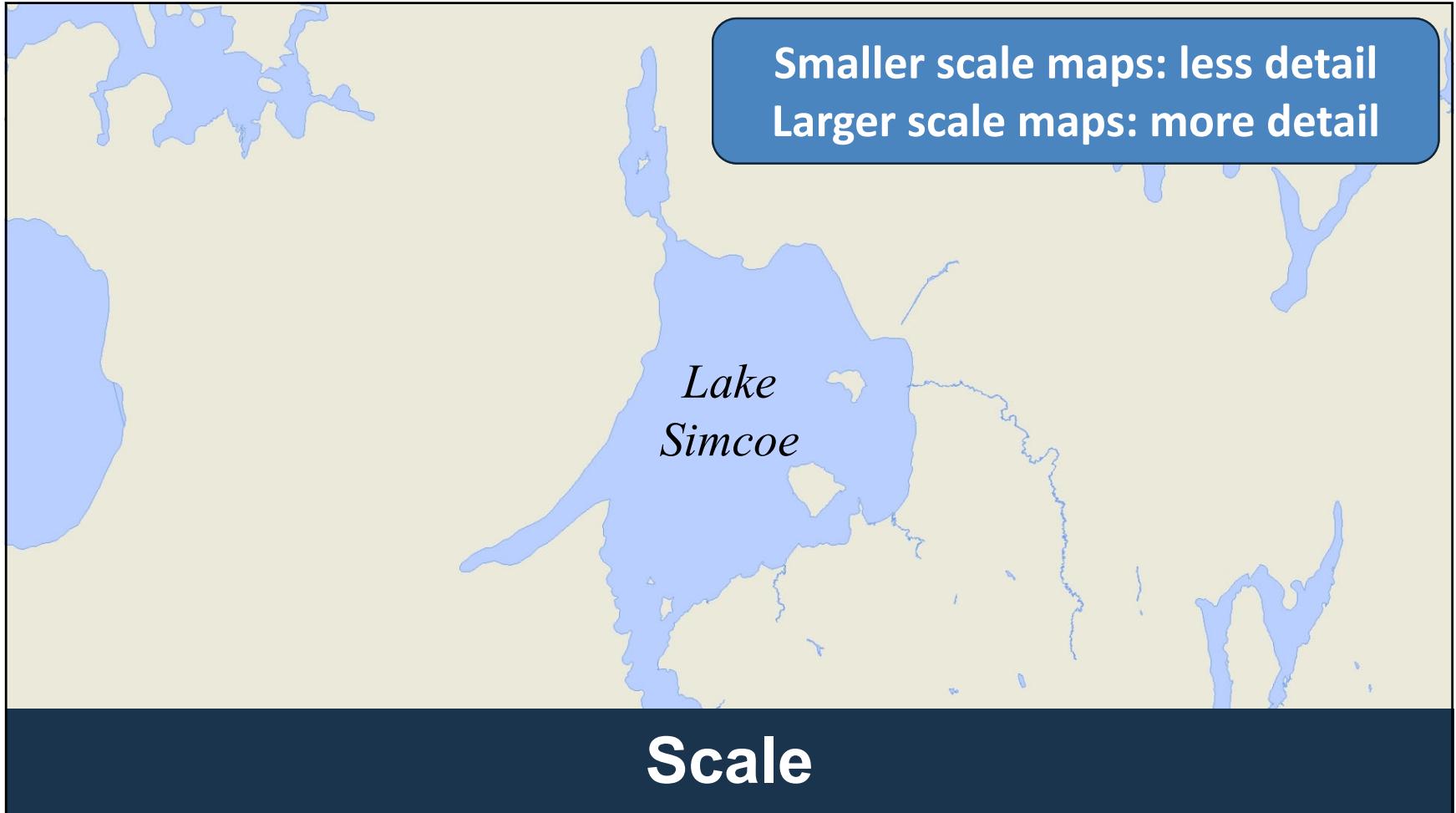
Traced at 1:5,000
Displayed at 1:50,000

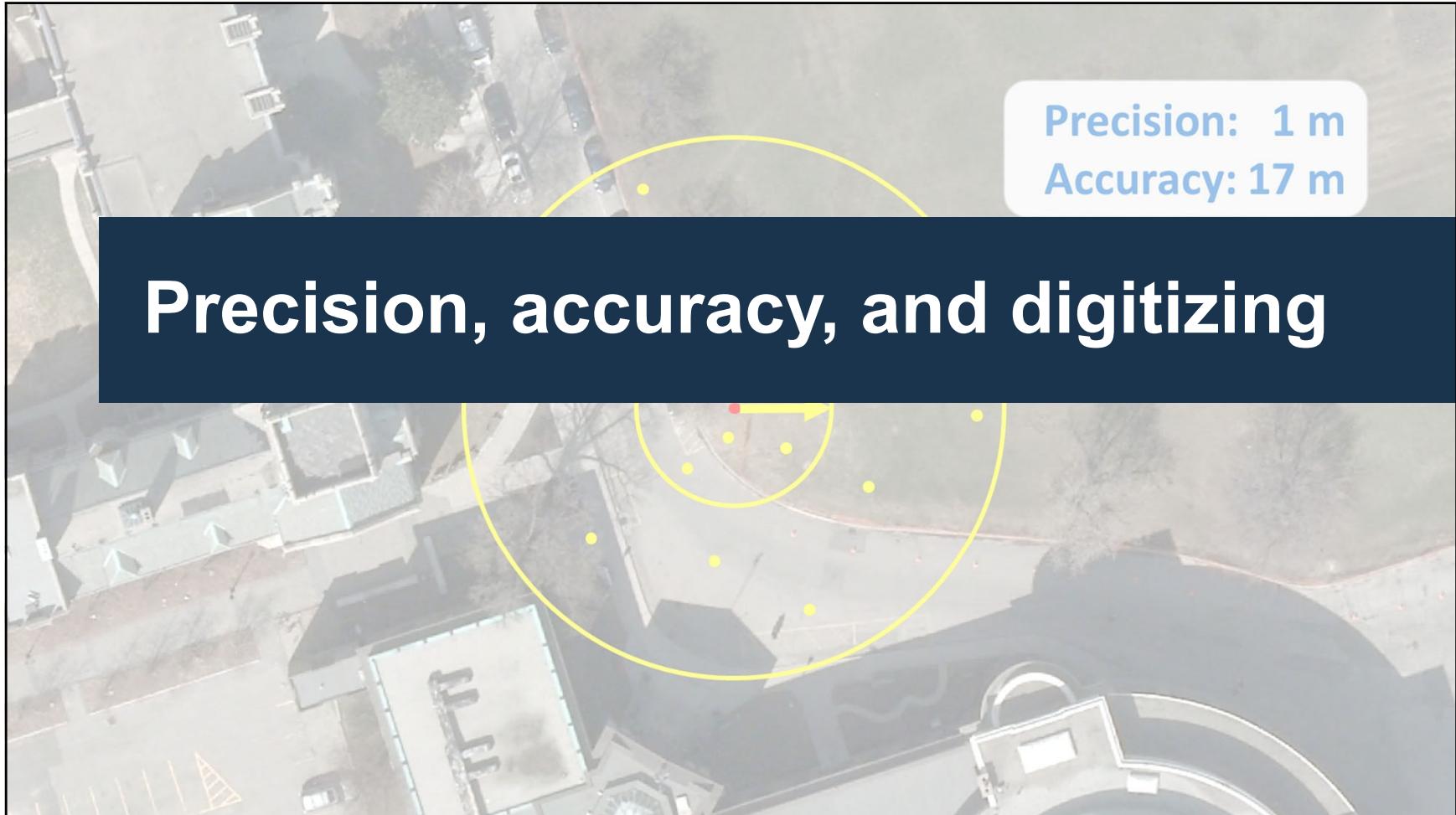
Scale: digitizing vs. display



Scale: digitizing vs. display





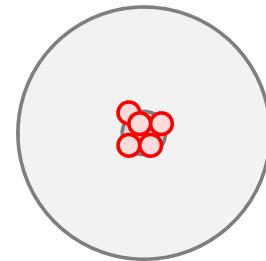












high accuracy

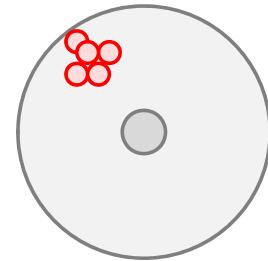
Difference between recorded value and true value

Accuracy



- The fineness of a measurement
- What time is it?
 - ◆ February
 - ◆ Wednesday
 - ◆ Morning
 - ◆ 5:23 am

Precision



high precision
low accuracy

Fineness of measurements

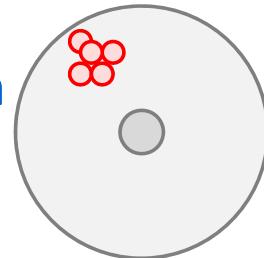
Precision



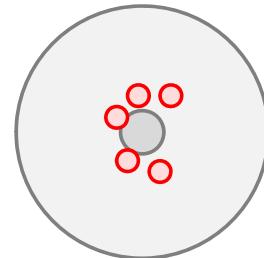
42.965044 m

Precision vs. accuracy

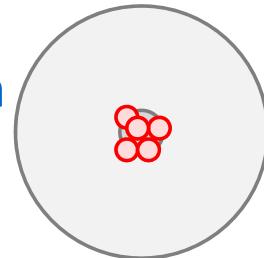
**High precision
Low accuracy**



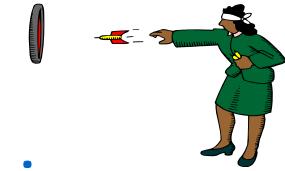
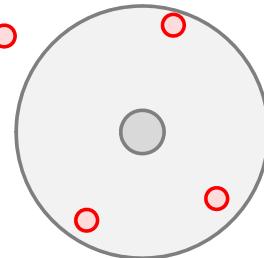
**Low precision
High accuracy**



**High precision
High accuracy**



**Low precision
Low accuracy**



Precision and Accuracy



Traced at 1:5,000
Displayed at 1:5,000

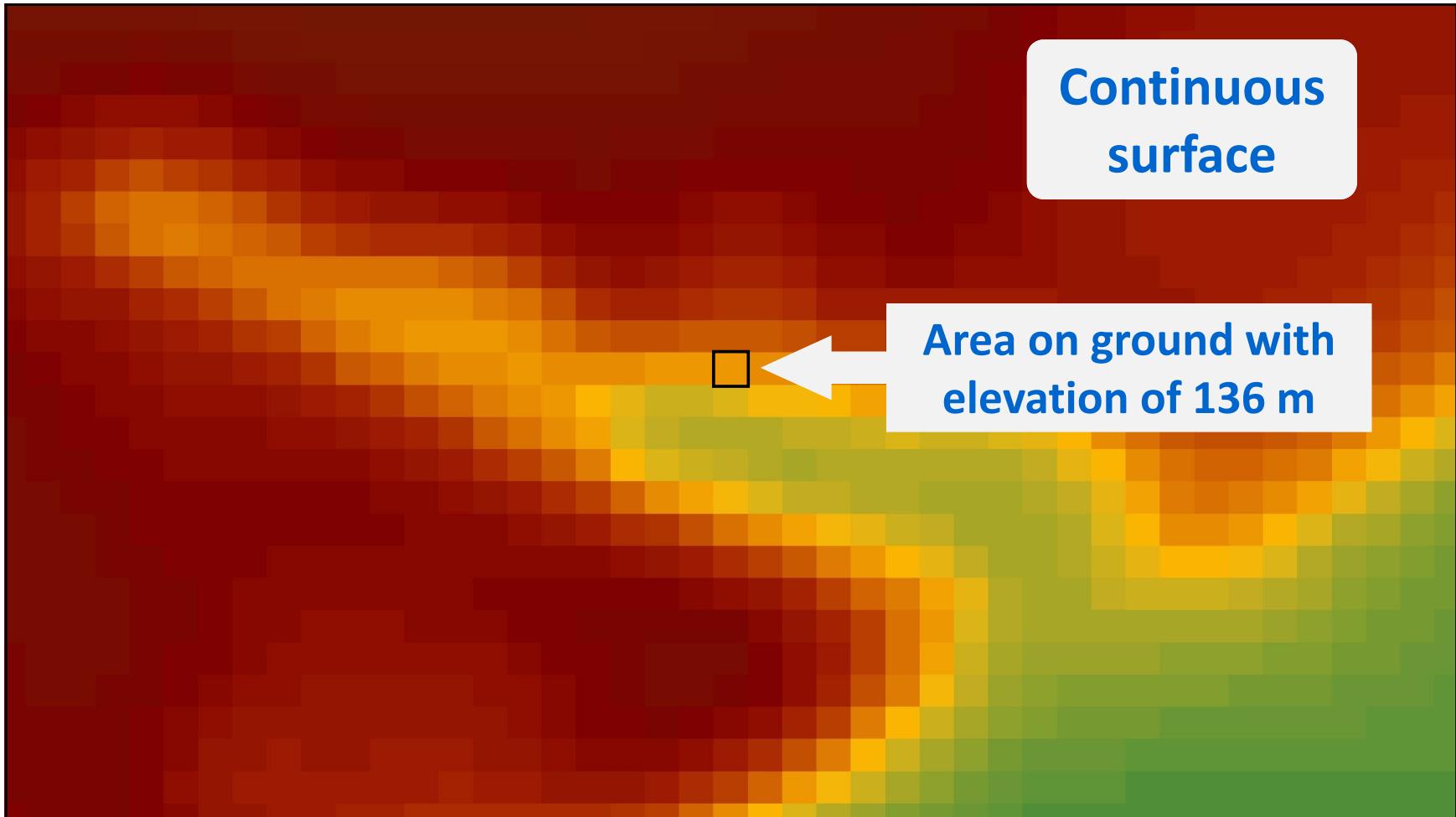
What scale should be used when tracing?

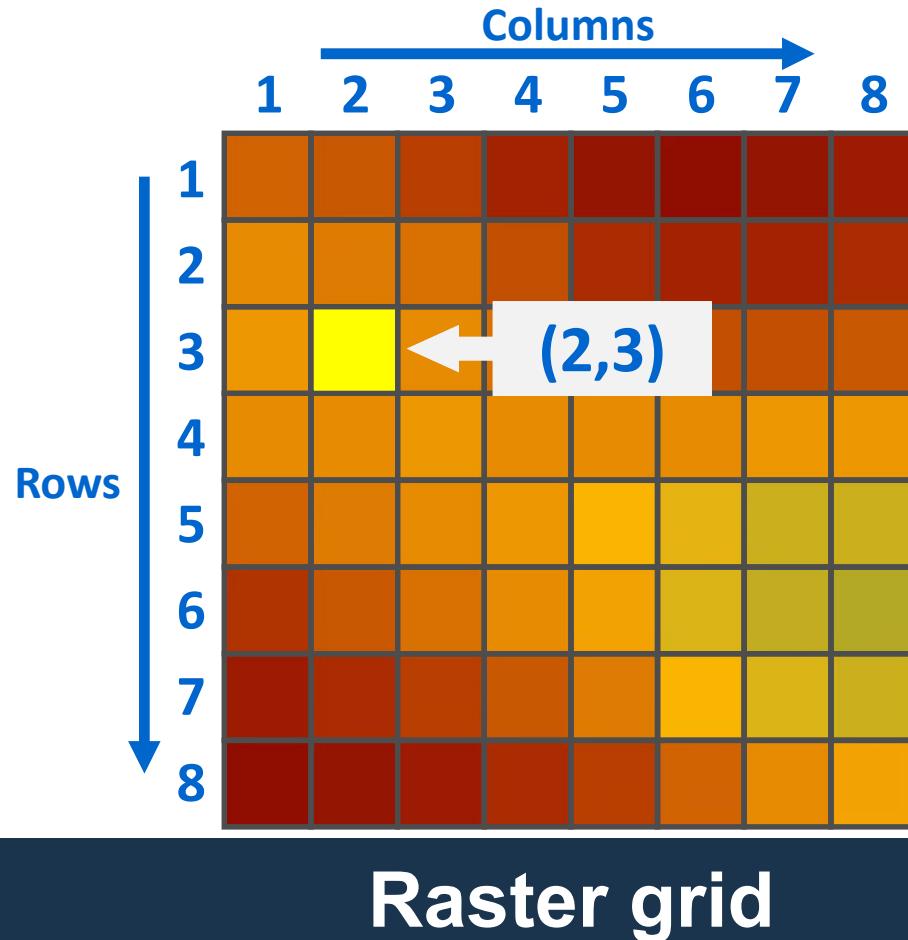


Data acquisition

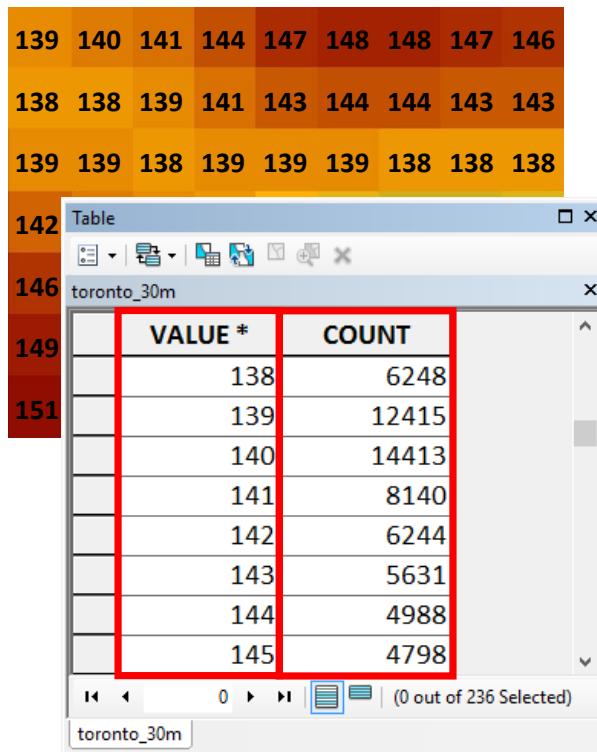
- At what scale was it digitized?
- Is it appropriate for my purpose?

Raster data model

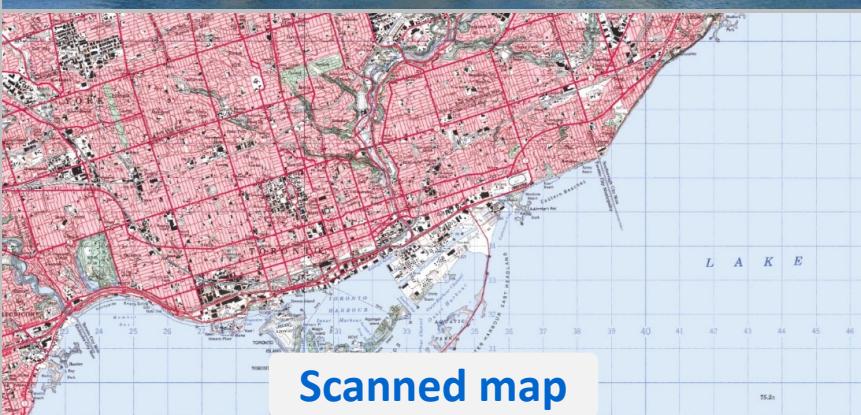
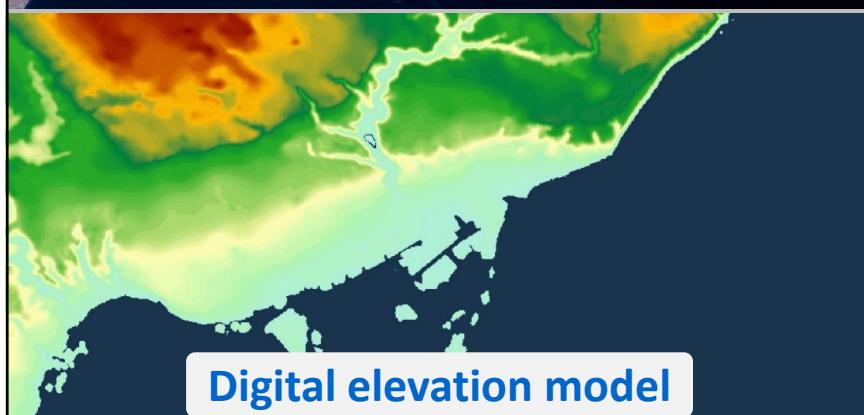




Cell Values



- Each cell has one value
- Integer or real
- Attribute table:
 - ◆ Value
 - ◆ Count

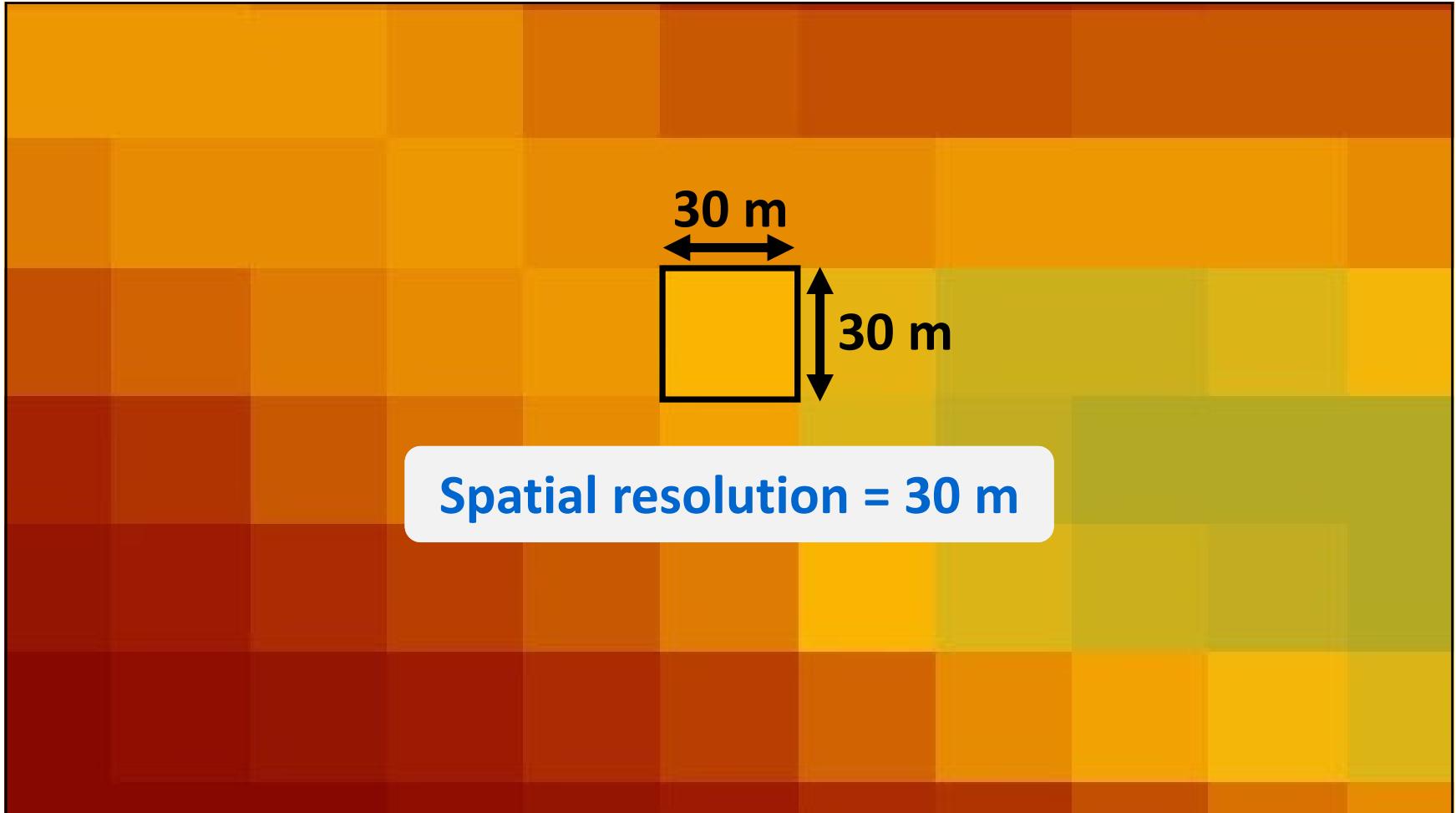


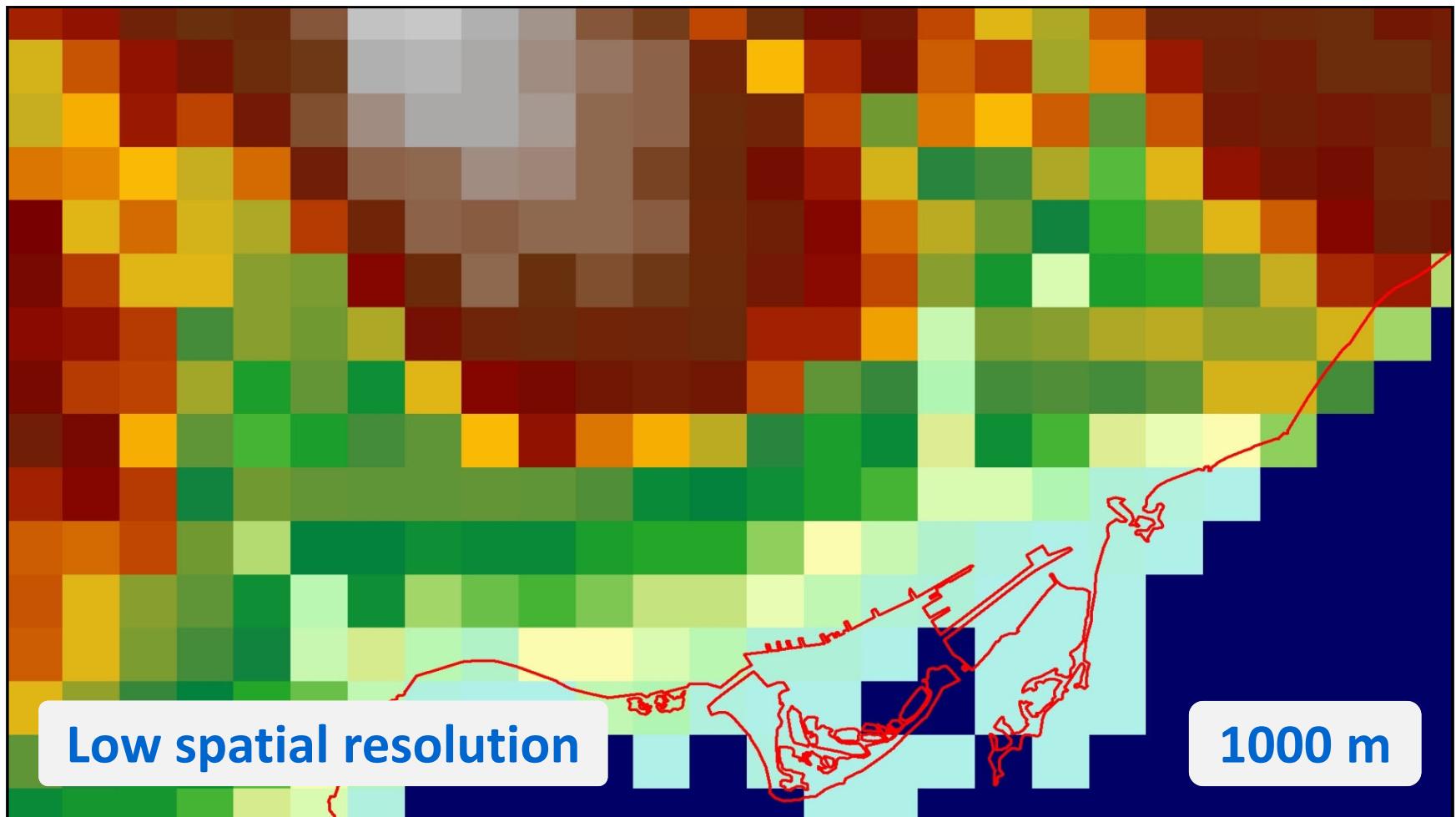
Digital elevation model

Scanned map

Raster data

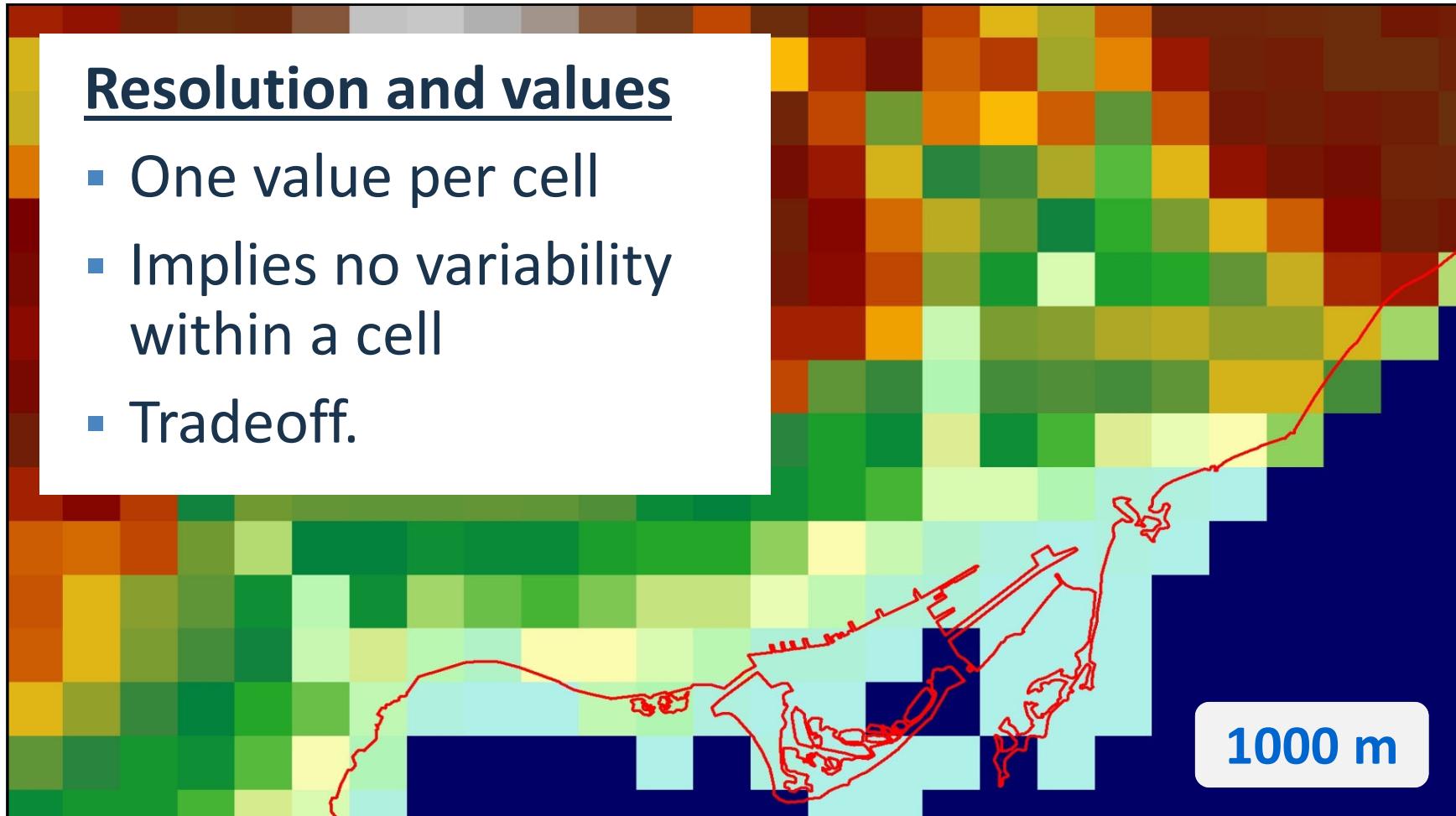


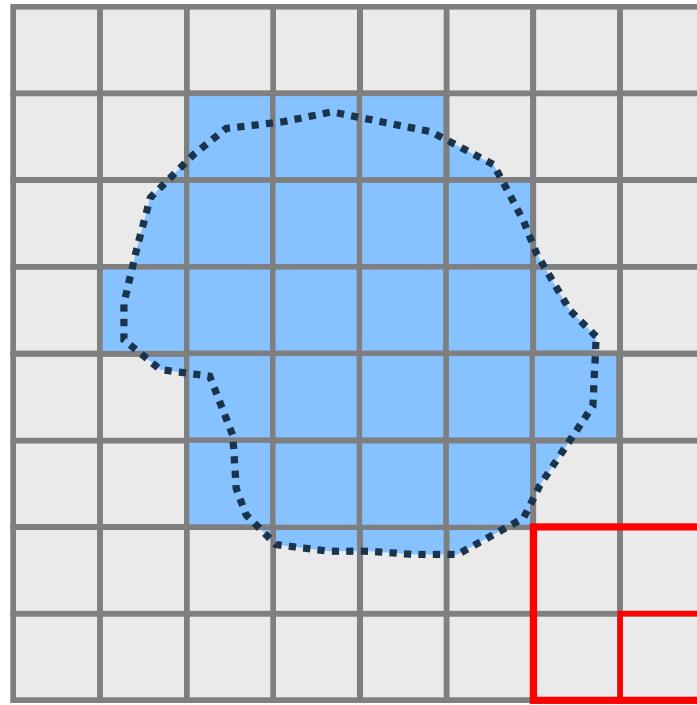




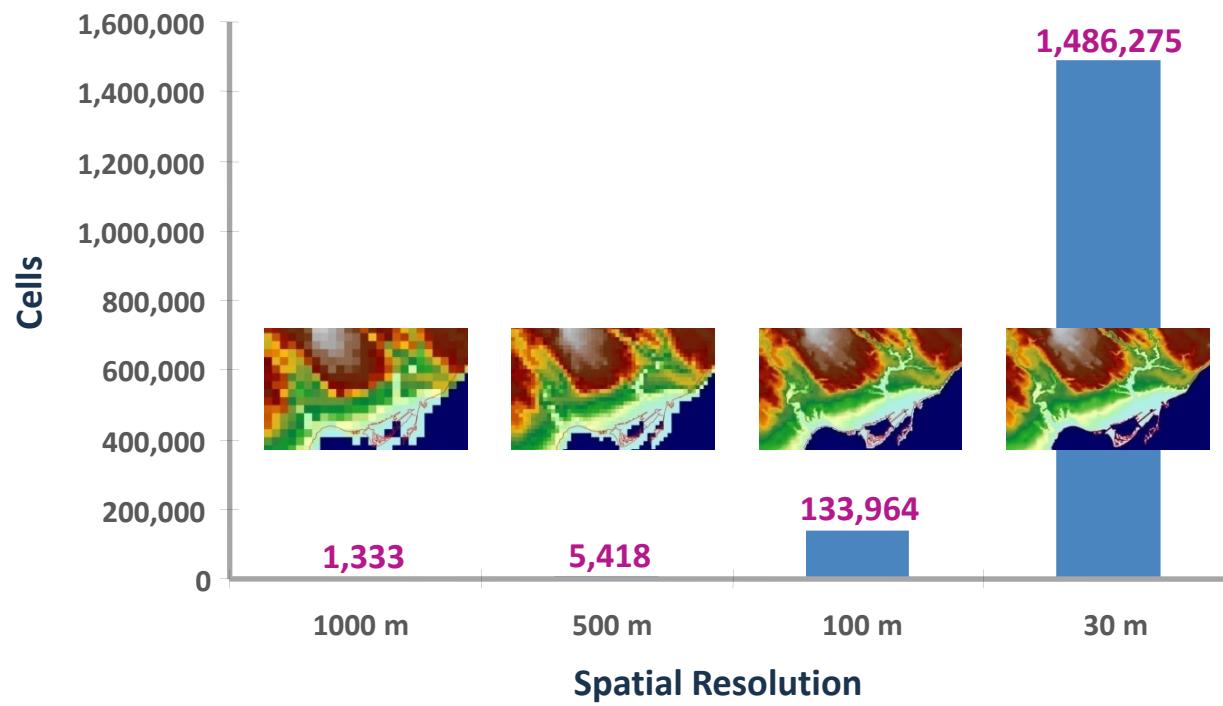
Resolution and values

- One value per cell
- Implies no variability within a cell
- Tradeoff.





2x resolution means 4x data volume



Resolution vs. data volume

ArcGIS for Desktop Documentation Pricing Support SEARCH Sign In English esri

ArcMap

Home Get Started Map Analyze Manage Data Tools More...

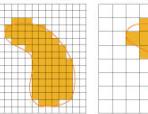
Manage Data > Data types > Raster and images > Fundamentals of raster data

- ▶ Introduction
- ▼ Fundamentals of raster data
 - Cell size of raster data**
 - Raster bands
 - How features are represented in a raster
 - Discrete and continuous data
 - Raster dataset zones and regions
 - Raster dataset attribute tables
 - Rasters with functions
 - Raster data organization
 - Gathering basic raster dataset information
- ▶ Supported raster data
- ▶ Properties of raster data
- ▶ Building and managing a raster database
- ▶ Displaying raster data
- ▶ Processing and analyzing raster data
- ▶ Serving raster data
- ▶ Tutorial and workflows

Cell size of raster data

Types of resolution
Spatial resolution versus scale

The level of detail (of features/phenomena) represented by a raster is often dependent on the cell (pixel) size, or spatial resolution, of the raster. The cell must be small enough to capture the required detail but large enough so computer storage and analysis can be performed efficiently. More features, smaller features, or a greater detail in the extents of features can be represented by a raster with a smaller cell size. However, more is not often better. Smaller cell sizes result in larger raster datasets to represent an entire surface; therefore, there is a need for greater storage space, which often results in longer processing time.

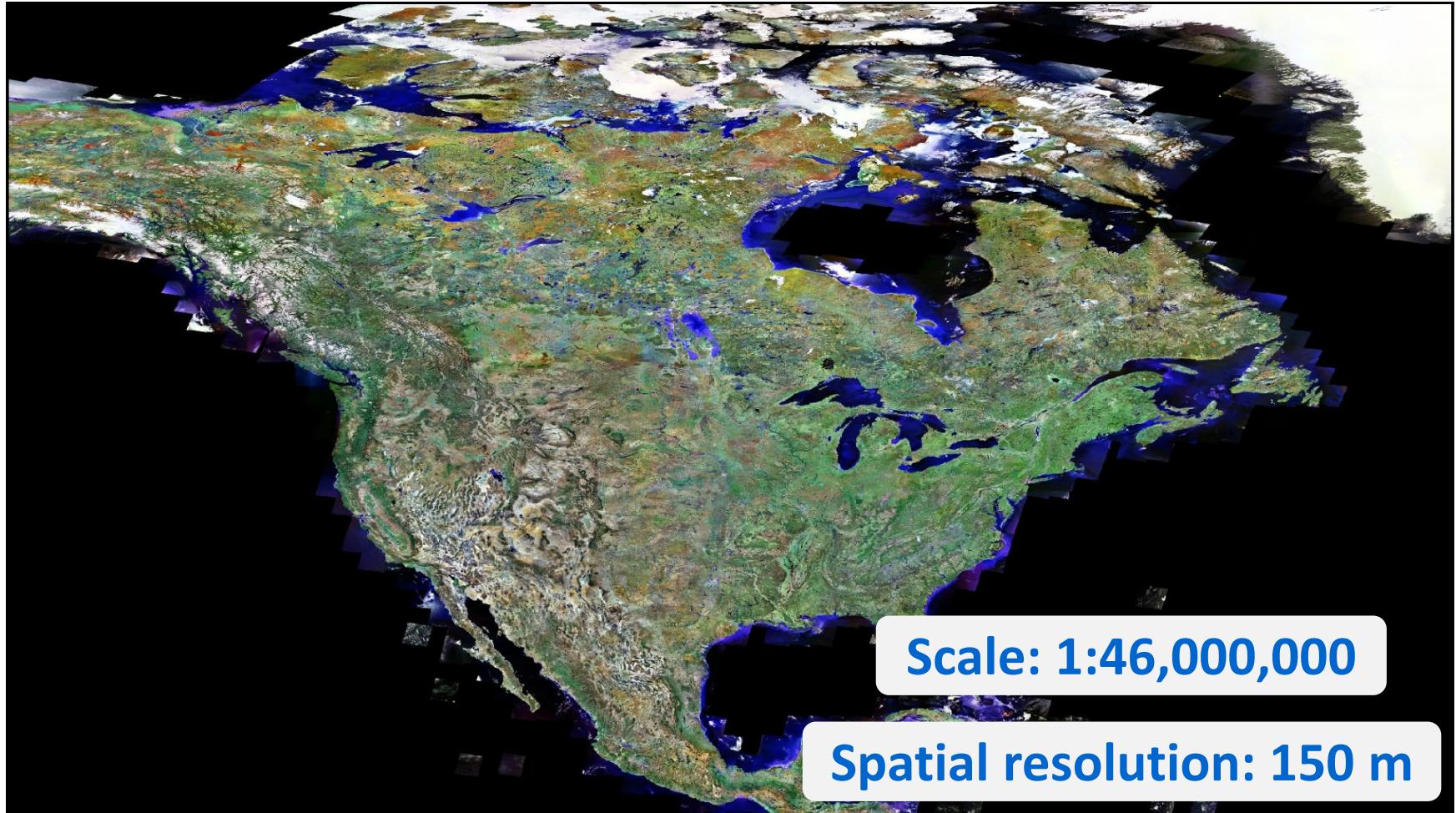
 71 m ² polygon	 73 m ² 1 m cell 16 x 16 cells	 72 m ² 2 m cell 8 x 8 cells	 80 m ² 4 m cell 4 x 4 cells
--	---	--	--

Comparing small versus large cell sizes

- Smaller cell size
 - Higher resolution
 - Higher feature spatial accuracy
 - Slower display
 - Slower processing
 - Larger file size
- Larger cell size
 - Lower resolution
 - Lower feature spatial accuracy
 - Faster display
 - Faster processing
 - Smaller file size

Learn about displaying the raster's spatial resolution in ArcMap

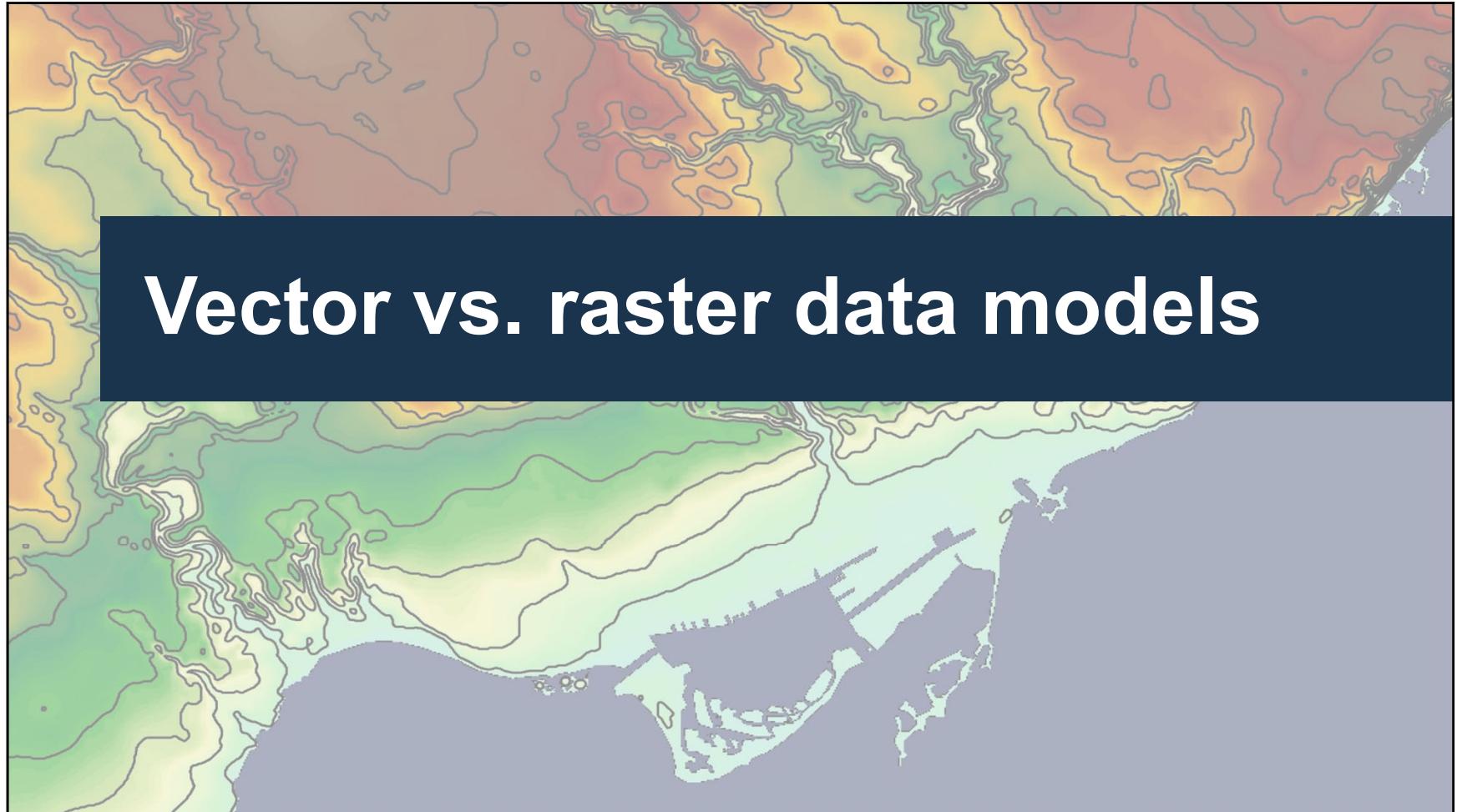
Choosing an appropriate cell size is not always simple. You must balance your application's need for spatial resolution with practical requirements for quick display, processing time, and storage. Essentially, in a GIS, your results will only be as accurate as your least accurate dataset. If you're using a classified dataset derived from 30-meter resolution Landsat imagery, then creating a digital elevation model (DEM) or other ancillary data at a higher resolution, such as 10 meters, may be unnecessary. The more homogeneous an area is for critical variables, such as topography and land use, the larger the cell size can be without affecting accuracy.

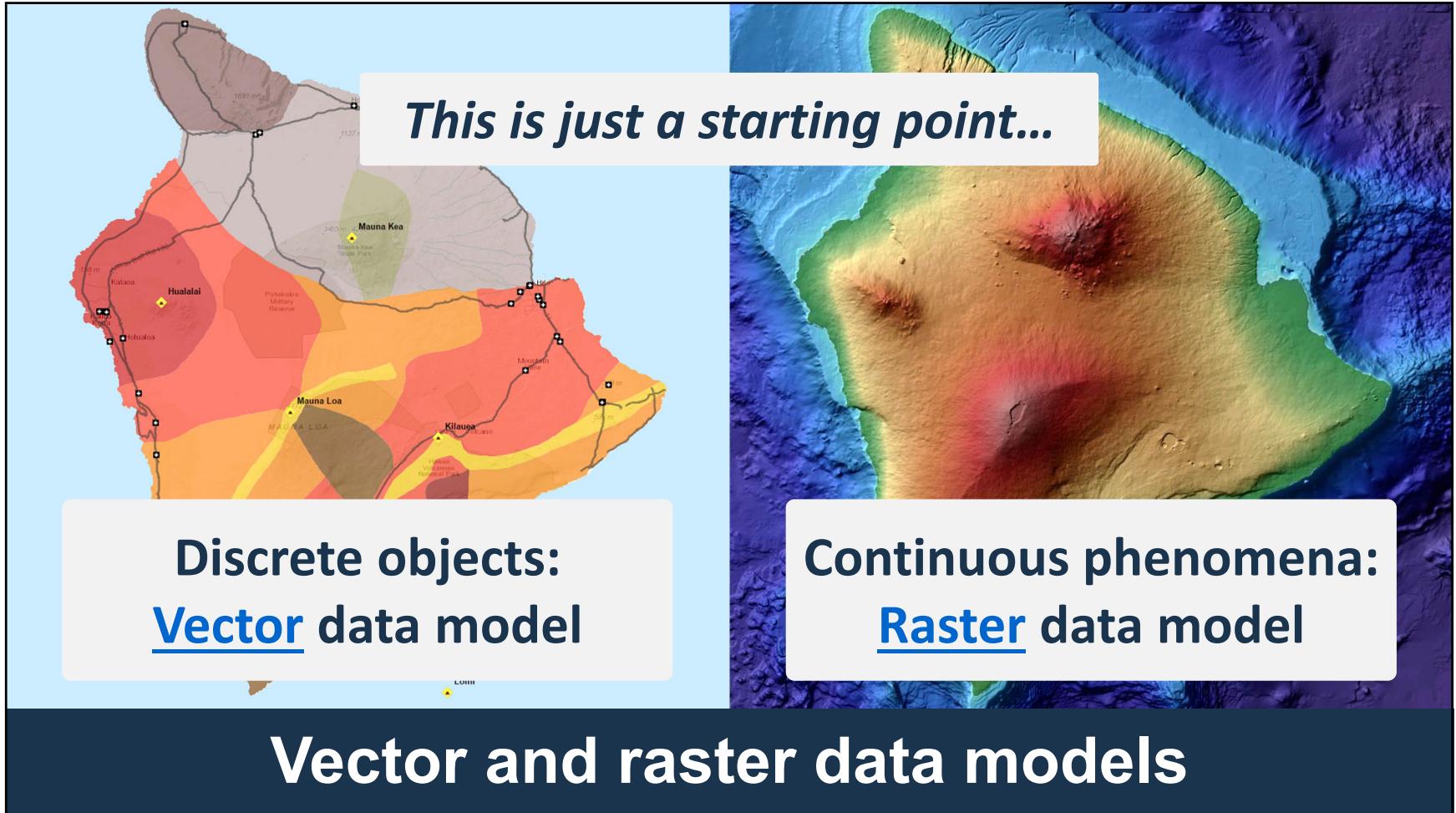


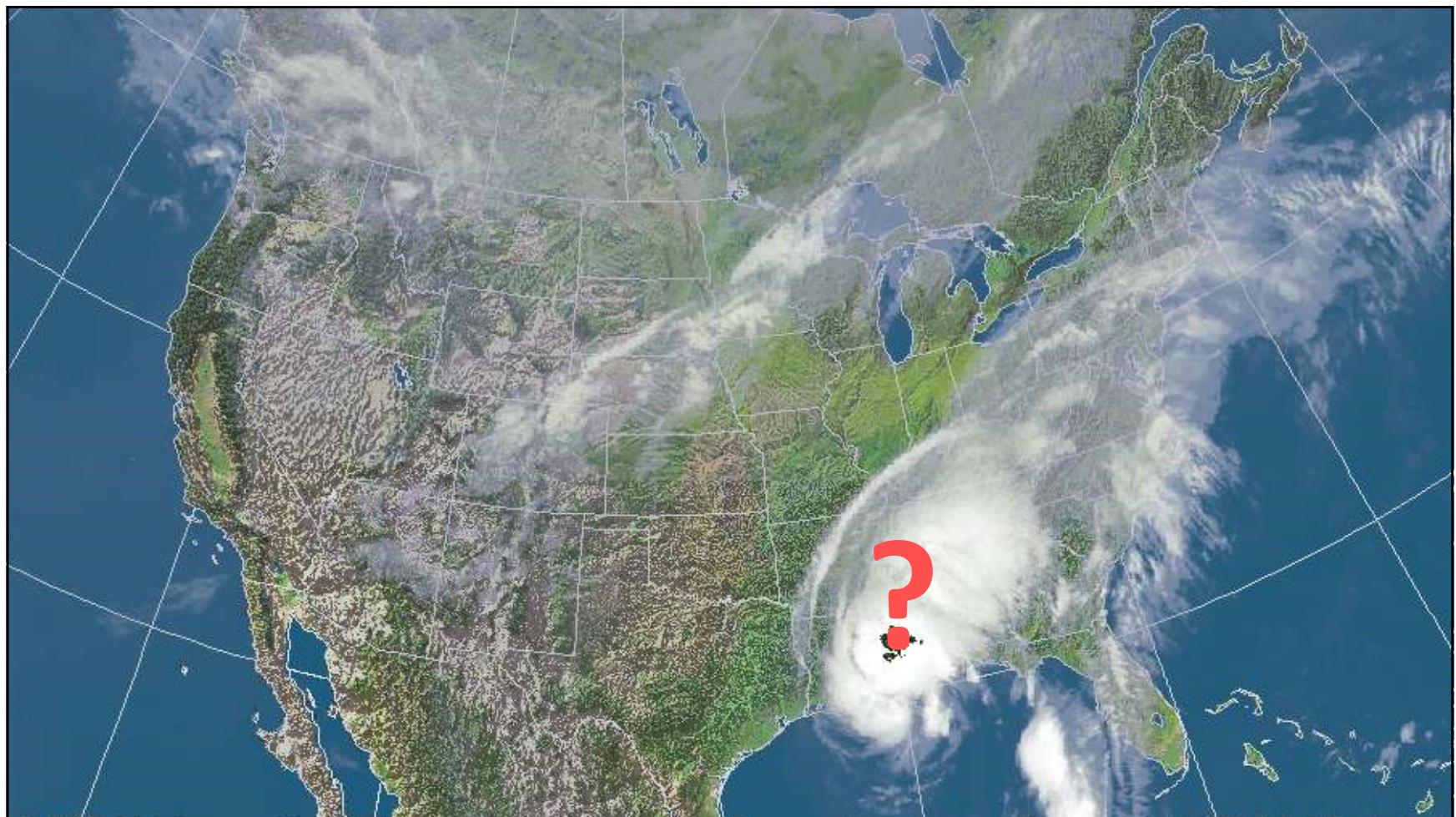
0	0	0	0	0	0	0	0
0	0	1	1	1	0	0	0
0	0	1	1	1	1	0	0
0	1	1	1	1	1	0	0
0	0	1	1	1	1	1	0
0	0	0	1	1	1	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

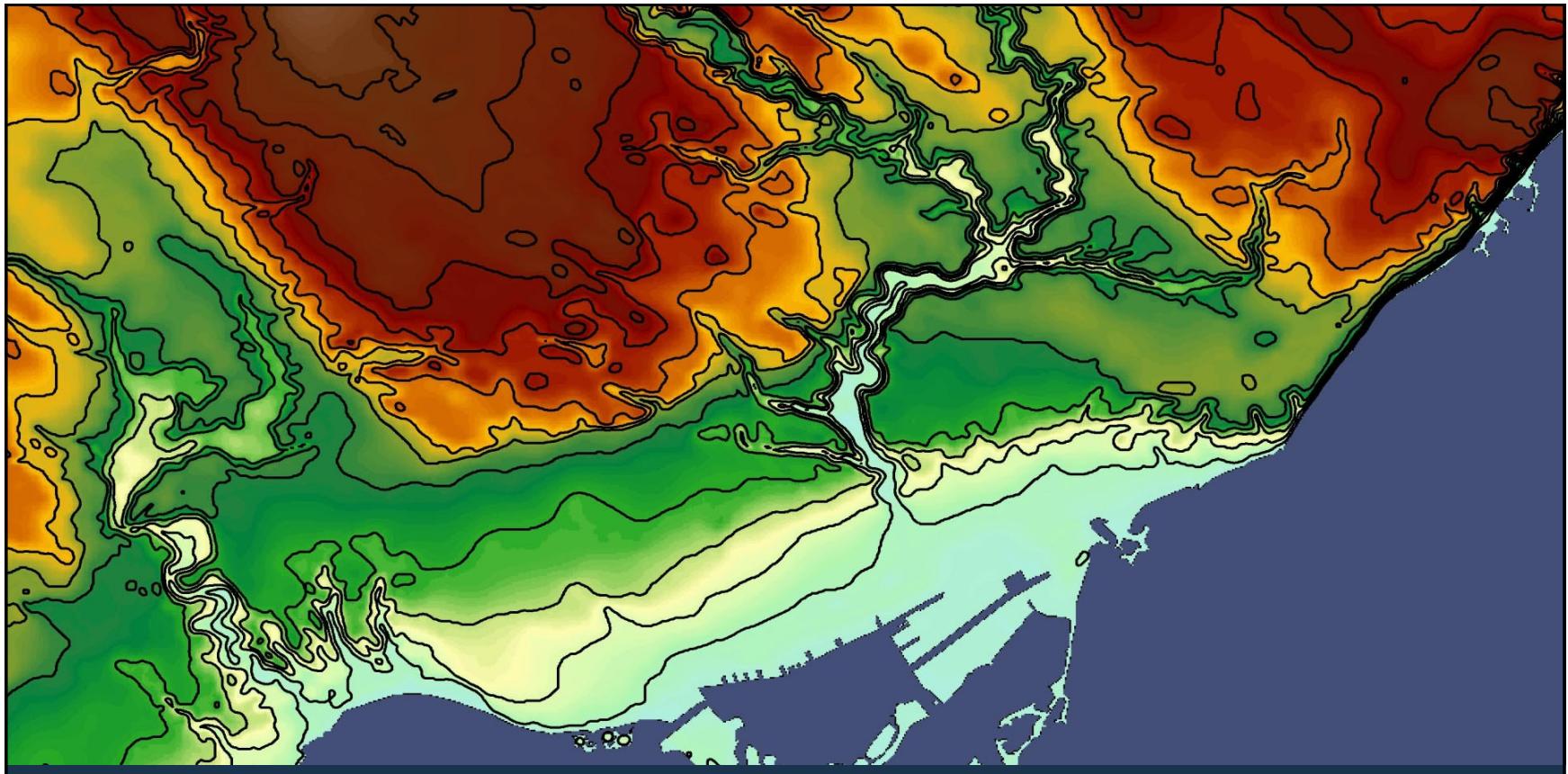
0,8		
0,2	1,3	0,3
0,2	1,4	0,2
0,1	1,5	0,2
0,2	1,5	0,1
0,3	1,3	0,2
0,8		
0,8		

Data compression: run-length encoding

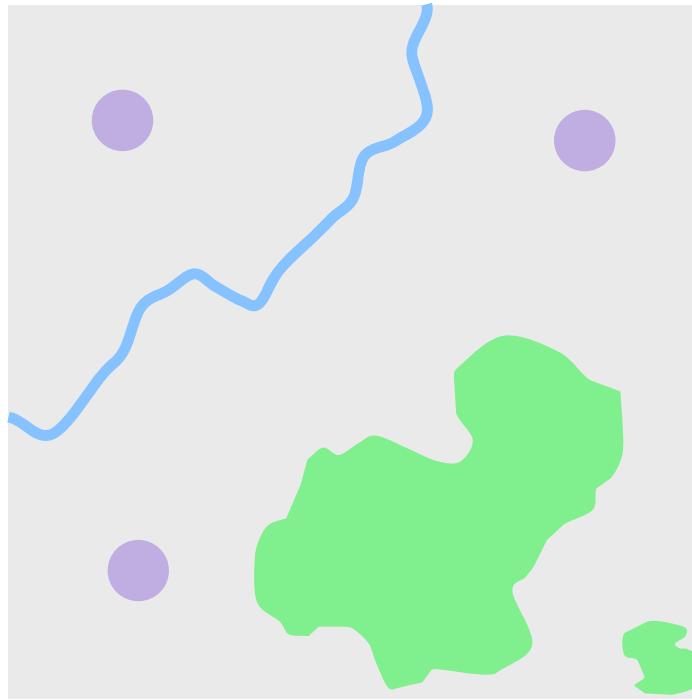




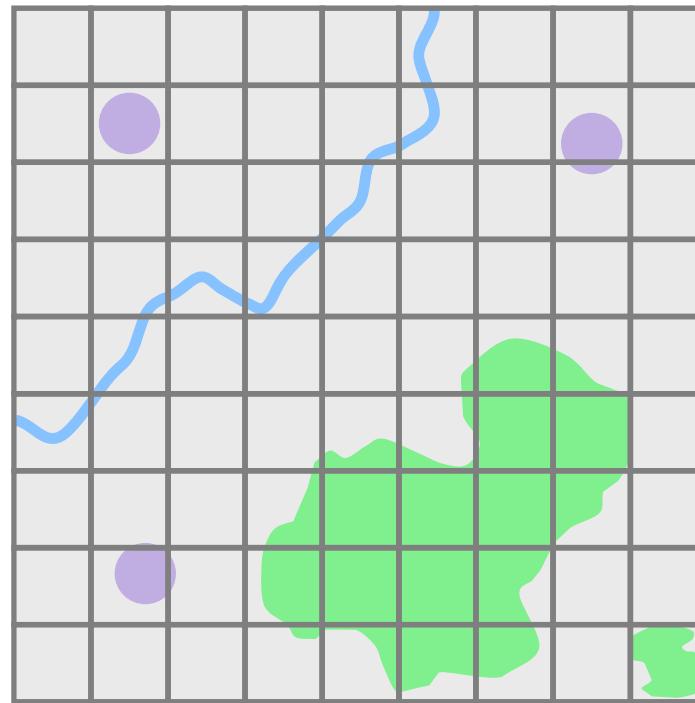




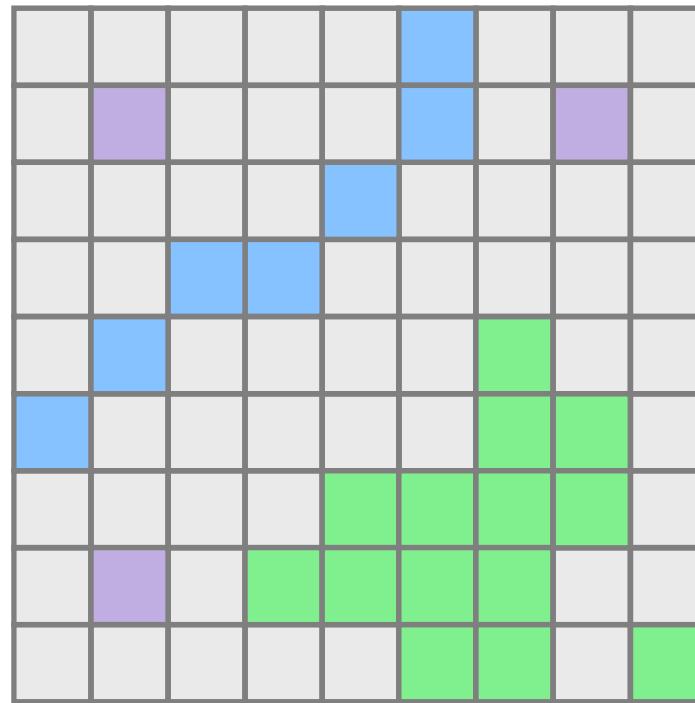
Representing elevation



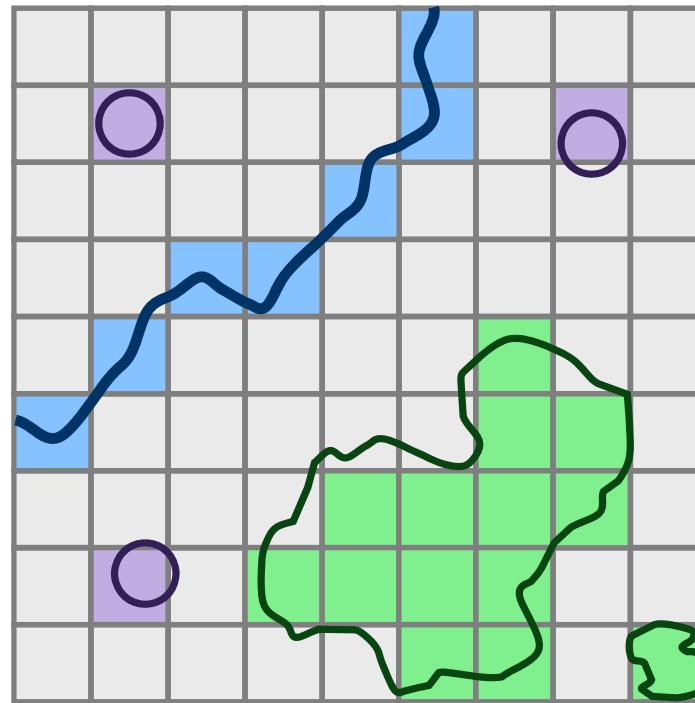
Discrete objects



Rasterizing



Raster cells



Loss of information

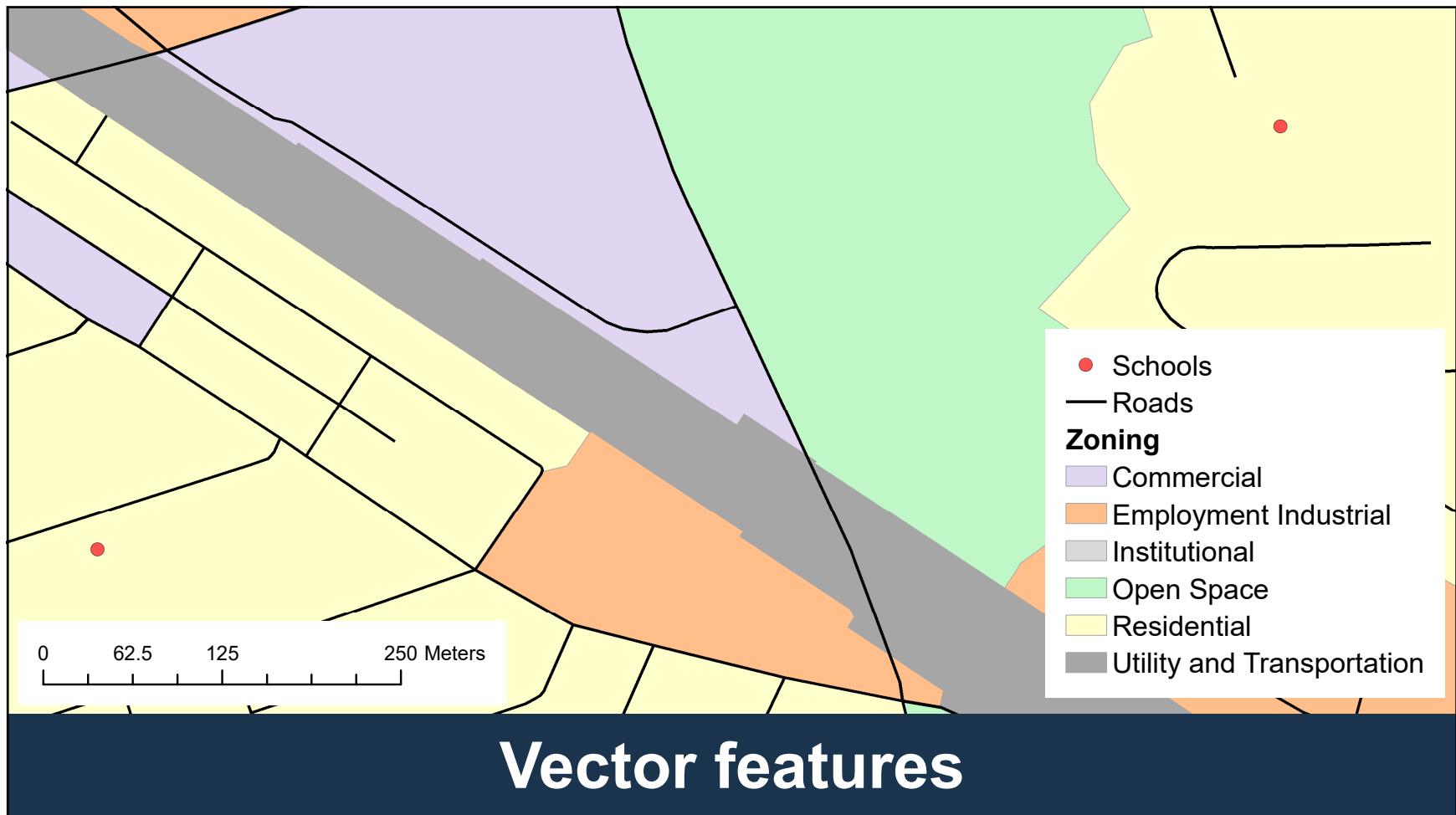
0	0	0	0	0	2	0	0	0
0	1	0	0	0	2	0	1	0
0	0	0	0	2	0	0	0	0
0	0	2	2	0	0	0	0	0
0	2	0	0	0	0	3	0	0
2	0	0	0	0	0	3	3	0
0	0	0	0	3	3	3	3	0
0	1	0	3	3	3	3	0	0
0	0	0	0	0	3	3	0	3

Discrete
objects stored in
raster format

No points, lines or polygons - just cells with same value

0	0	0	0	0	2	0	0	0
0	1	0	0	0	2	0	1	0
0	0	0	0	2	0	0	0	0
0	0	2	2	0	0	0	0	0
0	2	0	0	0	0	3	0	0
2	0	0	0	0	0	3	3	0
0	0	0	0	3	3	3	3	0
0	1	0	3	3	3	3	0	0
0	0	0	0	0	3	3	0	3

Assign colours to add meaning





Points as vector and raster

